

Specifications

For

City Elevator Design – 525 Building
525 South Mill Avenue
Tempe, Arizona 85281

City of Tempe CIP # 6708841R

2/18/21

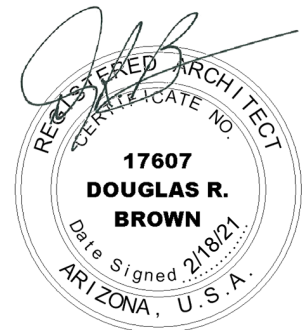


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SECTION 01 11 00

SUMMARY OF WORK

PART 1 GENERAL

1.01 DESCRIPTION

- A. Work Included: This specification covers the modernization of two (2) in-ground hydraulic passenger elevators located at the Tempe 525 Building. The elevators consist of a rated capacity of 3,500 lbs. and a rated speed of 150 fpm serving three (3) stops with three (3) openings. While specifications address requirements for standards, it is of utmost importance that all existing elevator equipment retained during the modernization is made to operate as new, tested, warranted and guaranteed as if new. Mechanical and electrical work includes providing code complaint dedicated machine room cooling unit and circuits for replacement of hydraulic elevators. Circuits include dedicated pit receptacles and lighting, equipment room lighting, and elevator controller refeeds.
- B. Maintenance of two (2) existing and modernized hydraulic passenger elevators.
- C. All work described in the following related Sections:
 - 1. Division 01 – General Requirements
 - 2. Division 02 – Existing Conditions
 - 3. Division 14 – Conveyances
 - 4. Division 23 – Heating, Ventilating, and Air Conditioning
 - 5. Division 26 – Electrical

1.02 GENERAL RESPONSIBILITIES

- A. Ensure that all work is performed in accordance with the requirements of Federal, State, and Local Codes and Regulations, which govern the requirements of the work specified.
- B. Perform thorough field surveys in addition to providing engineering, labor, materials, storage, tools, equipment, supervision and transportation to fulfill the requirements for design, in a first-class manner and in accordance with the requirements of the contract documents
- C. Perform all demolition and provide required cutting, alterations, and removal as may be required.

- D. The Contractor is responsible for keeping the premises clean at all times during the performance of the work. All removed and demolished equipment must be removed from the project premises on a continual basis. Take positive action to protect all existing surfaces and facilities from any damage resulting from construction operations unless modifications to the surfaces or facilities are required as part of the Contract.
- E. Provide scaffolding, ladders and other equipment for installation of equipment and materials including protection features and as required by The City of Tempe and its representatives to inspect the quality of work.
- F. All Contractor representatives and construction workers who will be on site are required to comply with all City of Tempe security requirements.
- G. Contractor acknowledges that the project site will be occupied during the execution of the work and as such will take all reasonable measures to limit construction dust, debris, and noise during normal building operating hours. Full barricades are required with a painted smooth side with a door while working in elevator lobbies.
- H. Contractor is responsible for the safety of his workers and occupants for the duration the project and as a minimum the Contractor must adhere to OSHA Standards. Contractor is required to submit for approval a safety plan that illustrates the standards and procedures to be adhered to throughout this project.
- I. Contractor must submit their QAQC plan with their proposal.
- J. Working hours are from 6:00am to 4:00pm Monday – Friday.
- K. Work that will emit fumes to be completed only between the hours of 12 AM and 4 AM. The City of Tempe must approve any afterhours schedule and/or submitted work.
- L. Equipment staging area to be determined by City of Tempe following award at Pre-Conference.
- M. Contractor shall field verify and is responsible for all field dimensions and measurements.
- N. All existing flooring and finishes shall be protected at all times.



PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 12 16

WORK SEQUENCE

PART 1 GENERAL

1.01 DESCRIPTION

- A. Work Included: This specification covers the sequence of work under this project.
 - 1. Throughout the progress of the work, perform coordination responsibilities as defined herein and as noted in related sections of this specification.
 - 2. Coordinate the work with City of Tempe employees and subcontractor(s).
 - 3. Expedite coordination process to assure compliance with schedule and the project work sequence.
- B. Related Work:
 - 1. Specialty work as defined in various other divisions of the Specifications.
 - 2. Requirements of the Agreement.

1.02 COORDINATION

- A. The Contractor is aware that the Building will be fully occupied and in full operation during performance of work described under the contract documents. The Contractor shall be responsible to ensure that the work to be performed under the contract documents by any and all subcontractors is coordinated in a manner to eliminate any negative impact to the normal operation of the facility.

1.03 WORK SEQUENCE

- A. The Contractor shall remove from service only one (1) elevator at a time until construction is completed.
- B. The Contractor shall coordinate with the City of Tempe the order of preference in which the elevators are to be removed from operation for modernization.
- C. The City of Tempe shall have final decision on sequence of the removal of the elevators. The Contractor will provide necessary adjustments for the sequence.

- D. The removal from service and modernization of existing Elevators must be coordinated with The City of Tempe taking into account schedule of public hours in the Administration Office.

1.04 SCHEDULE

- A. Bidders to provide a CPM format schedule in their Bid proposal.
- B. An updated detailed CPM format schedule shall be provided after the completion of each elevator.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 25 00**MEASUREMENT AND PAYMENT****PART 1 GENERAL**

Measurement and payment for all pay items in the proposal shall be as specified in the latest editions in the applicable section of the Maricopa Association of Governments Uniform Standard specifications for Public Works Construction (MAG Specifications), and City of Tempe supplements to MAG, and any applicable City specifications or Standards as referenced, and/or as modified in these Technical Specifications. In the event of a conflict between these Specifications and the requirements of any plans, detail drawings, or City Standard Details and the MAG Specifications, these Technical Specifications shall prevail.

Payment of the contract items shall be consistent with the description of unit prices in MAG Specification Section 109.2 and furthermore shall be compensation in full for furnishing all overhead, labor, material, tools, equipment, and appurtenances necessary to complete the work in a good, neat, and satisfactory manner as specified, with all necessary connections and appurtenances for the satisfactory use of and/or operation of said item. No additional payment will be made for work related to each item unless specifically noted or specified. Measurement will be in place for the completed work with no allowance for waste or the disposal thereof. All surplus materials and waste shall be immediately hauled from the job site and disposed in accordance with Section 205 of the MAG Specifications; and the cost shall be incidental to its respective item below.

ITEM 1 – General Construction**Description:**

Construction shall occur in accordance with MAG Standard Specifications and as indicated under Division 1 through Division 26 of these Technical Specifications except as indicated under Item 2 – Cab Interior Allowance.

Method of Measurement:

Measurement of all general construction as described herein and as required for the project will be measured on a lump sum basis.

Basis of Payment:

Payment for all general construction work will be paid for at the lump sum amount indicated on the Schedule of Bid Items, which payment will be considered full compensation for the work complete as described herein and on the plans.

ITEM 2 – Cab Interior Allowance

Description:

Construction shall occur in accordance with MAG Standard Specifications and as indicated under Section 14 24 10, Hydraulic Passenger Elevator-Modernization.

Method of Measurement:

Cab Interior Allowance will be measured as an allowance. It shall be the Contractor's responsibility to immediately notify the City when this item's expenditure reaches 80% of the allowance amount.

Basis of Payment:

Cab Interior Allowance will be paid as measured above. The contract allowance price will be paid upon complete documentation submittal to and approved by the Construction Manager and shall be full compensation for the item, completed as defined and described above. The allowance for the Cab Interior should not exceed \$50,000 - \$25,000 for the #1 Elevator at 525 Building and \$25,000 for the #2 Elevator at 525 Building for this single complete item of work, with no mark-up, which shall be full compensation for the item complete in place.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 29 10

SCHEDULE OF VALUES

PART 1 GENERAL

1.01 DESCRIPTION

- A. Submit to ENGINEER for acceptance a Schedule of Values that allocates cost to each item of the Work. Schedule of Value list of line items shall correspond to each aspect of the Work, establishing in detail the portion of the Contract Price allocated to each major component of the Work.
- B. Upon request of ENGINEER, support values with data that substantiate their correctness.
- C. Submit preliminary Schedule of Values to ENGINEER for initial review. CONTRACTOR shall incorporate ENGINEER's comments into the Schedule of Values and resubmit to ENGINEER. ENGINEER may require corrections and re-submittals until Schedule of Values is acceptable.
- D. Schedule of Values and the Progress Schedule updates specified in Section 01 12 16, Work Sequence, shall be basis for preparing each Application for Payment. Schedule of Values may be used as a basis for negotiating price of changes, if any, in the Work.
- E. Include in Schedule of Values unit price payment items with their associated quantity. Provide in the Schedule of Values detailed breakdown of unit prices when required by ENGINEER.
- F. Include in Schedule of Values itemized list of Work for each major part of the Contract, for each payment item specified in Section 01 25 00, Measurement and Payment, and shall be grouped in a sufficient number of line items as deemed necessary by CONSTRUCTION MANAGER to adequately evaluate payment applications.
- G. Requirements for preliminary Schedule of Values and Schedule of Values are:
 - 1. Schedule of Values shall show division of Work between CONTRACTOR and Subcontractors. Line items for Work to be done by Subcontractor shall include the word, "(SUBCONTRACTED)".
 - 2. Schedule of Values shall include breakdown of costs for materials and

equipment, installation, and other costs used in preparing the Bid by CONTRACTOR and each Subcontractor. List purchase and delivery costs for materials and equipment for which CONTRACTOR may apply for payment as stored materials.

3. Include separate amounts for each Specification Section in the Contract Documents by structure, building, and work area.
4. Identify each line item with number corresponding to the associated Specification Section number. List sub-items of major products or systems, as appropriate or when requested by ENGINEER.
5. Sum of individual values shown on the Schedule of Values shall equal the total of associated payment item. Sum of payment item totals in the Schedule of Values shall equal the Contract Price.
6. Include a separate line item for proportioned billing of CONTRACTOR's taxes, overhead, and profit.
7. Include separate line item for each allowance, and for each unit price item
8. Include line item for bonds and insurance, in amount specified in CONTRACTOR'S bid. This may be applied for in the first Application for Payment.
9. Include items for the General Conditions, permits (when applicable) and other items required by ENGINEER. Include such items in Applications for Payment on schedule accepted by ENGINEER
10. Line items for Site maintenance such as dust control, compliance with storm water pollution prevention plans and permits, spill prevention control and countermeasures plans, and for construction photographic documentation; temporary utilities and temporary facilities, field offices, temporary controls, field engineering, and similar Work shall be included in the Schedule of Values and proportioned in Applications for Payment throughout duration of the Work.
11. Costs for stored materials will only be allowed for materials that are on the project site.
12. Cost for preparation of shop drawings and submittals will not be permitted.
13. Schedule of Values shall include an itemized list of Work by work area, as

applicable, for Work included in Section 01 31 13, Project Coordination.

14. Submit Schedule of Values on 8.5-inch by 11-inch white paper, using the continuation sheets of the Application for Payment form specified in Section 01 29 70, Progress Payment Procedures.
15. Coordinate Schedule of Values with resource loading and cost loading of the Progress Schedule, in accordance with Section 01 12 16, Work Sequence.

1.02 SUBMITTALS

A. Informational Submittals: Submit the following:

1. Submit to ENGINEER electronic copy of Schedule of Values.
2. Content of Schedule of Values submittals shall conform to Article 1.01 of this Section.
3. Time Frames for Submittals:
 - a. Submit preliminary Schedule of Values within ten days of date that the Contract Times commence running in accordance with the Notice to Proceed.
 - b. Submittal of the Schedule of Values shall be in accordance with the contract. ENGINEER will not accept Applications for Payment without an acceptable Schedule of Values.
 - c. When required by ENGINEER, promptly submit updated Schedule of Values to include cost breakdowns for changes in the Contract Price. Content of Schedule of Values submittals shall conform to Article 1.01 of this Section.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 29 70**PROGRESS PAYMENT PROCEDURES****Part 1 GENERAL****1.01 PROGRESS PAYMENT****A. General.**

1. CONTRACTOR's requests for payment shall be in accordance with the Contract and the Specifications.
2. Applications for Payment shall be in AIA form G702 and AIA form G703.

B. Procedure:

1. Review with ENGINEER quantities and Work proposed for each progress payment. Application for Payment shall include only Work and quantities recommended by the ENGINEER.
2. Submit to ENGINEER electronic Application for Payment and other documents to accompany the Application.
3. ENGINEER will act on request for payment in accordance with the Contract.

C. Each request for progress payment shall include:

1. Completed Application for Payment form, including summary/signature page, progress estimate sheets, and stored materials summary. Progress estimate sheets shall have same level of detail as the Schedule of Values.
2. For materials and equipment not incorporated in the Work but suitably stored, submit documentation. Legibly indicate on invoice or bill of sale the specific materials or equipment included in the Application and corresponding payment item number for each.
3. For Applications that include payment for Work under an allowance, submit documentation acceptable to OWNER of the authorization of allowance Work.
4. For Applications (other than request for final payment) that include reduction or payment of retainage in an amount greater than that required in the Contract Documents, submit on form acceptable to OWNER consent of surety to partial release or reduction of retainage.

D. Requirements for request for final payment are in Section 01 70 00, Project Closeout.**END OF SECTION**

SECTION 01 31 13

PROJECT COORDINATION

PART 1 GENERAL

1.01 DESCRIPTION

- A. Work Included: This specification covers project coordination responsibilities of the contractor under this project.
 - 1. Throughout the progress of the work, perform coordination responsibilities as defined herein and as noted in related sections of this specification.
 - 2. Coordinate the work with own employees and subcontractor(s).
 - 3. Expedite coordination process to assure compliance with schedule.
- B. Related Work:
 - 1. Specialty work as defined in various other divisions of the Specifications.
 - 2. Requirements of the Agreement.

1.02 COORDINATION

- A. The Contractor is fully responsible to ensure that the work to be performed under the contract documents by any and all subcontractors is coordinated in a manner to eliminate any negative impact to the schedule.
- B. The Contractor is to coordinate all delivery materials, tools and supplies required in the execution of the work to a secure location for storage of all project materials. All work related to noise and fumes that will interrupt operations will be performed shall be approved by the City of Tempe.
- C. Perform the Work such that OWNER's facility remains in continuous satisfactory operation during the Project. Schedule and conduct the Work such that the Work does not: impede OWNER's production or processes, create potential hazards to operating equipment and personnel, reduce the quality of the facility's products, or cause odors or other nuisances.
- D. Coordinate shutdowns of Elevators with OWNER and ENGINEER.
- E. Do not shut off or disconnect existing operating systems, unless accepted by ENGINEER in writing. Operation of existing equipment will be by OWNER unless otherwise specified or indicated.

F. The following constraints apply to coordination with OWNER's operations:

1. Operational Access: OWNER'S personnel shall have access to equipment and areas that remain in operation.
2. Temporary Partitions and Enclosures: Provide temporary partitions and enclosures necessary to maintain dust-free, heated, and ventilated spaces in areas that are adjacent to the Work and that must be kept operational.

1.03 PRE-CONSTRUCTION MEETINGS

- A. The Contractor shall attend a pre-construction meeting before each car is taking out of service with the City of Tempe or its representative to discuss work schedule, site restrictions and any other project concerns as required. Additionally, the contractor shall schedule and conduct a pre-construction meeting with its own subcontractors, suppliers, manufacturers, fabricators and other affected trades for each unit of work affecting proper sequencing of work.

1.04 PROGRESS MEETING

- A. Bi-weekly Progress Meetings.
- B. Progress meetings shall have inspections performed on the same day.
- C. Inspections for Architectural and Engineering shall be scheduled in advance as needed.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 40 00

QUALITY REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

- A. Work included: Establish and maintain a quality assurance/quality control (QA/QC) system and management program for each component and assemblies to be furnished and installed under this contract. The contractor shall have the "first order" responsibility for the quality of their work. A QA/QC checklist list shall be provided by the Contractor. The Checklist shall be approved and monitored by the City of Tempe and/or Owners Representative.
- B. Related work:
 - 1. Requirements of the Agreement.
 - 2. Specialty work as defined in various sections of this specification.

1.02 DEFINITIONS

- A. Quality Assurance (QA) is a program of policies, procedures and outline of detailed responsibilities to provide adequate confidence through approved surveillance and audit requirements that the contractor will meet the highest quality standards.
- B. Quality Control (QC) Quality Control is the act of examining, witnessing, inspecting, checking and testing of in-process or completed work to determine conformity with specified requirements and documenting the results.

- C. Inspection: A phase of Quality Control which by means of examination, observation, or measurement determines the conformance of materials, supplies components, parts, appurtenances, systems, processes, installation, or structures to predetermined quality requirements.

1.03 QUALITY ASSURANCE

- A. Engage adequate number of skilled professionals who are thoroughly trained, experienced and familiar with the specific requirements and methods needed for the proper performance of the work.
- B. Establish technical and administrative surveillance methods to ensure highest degree of quality, and to correct potential problems so as not to affect the contract schedule.
- C. Monitor quality control over suppliers, manufacturers, fabricators, products, services, site conditions, workmanship and installation to produce work of highest quality.
- D. Take corrective actions in a timely manner to identify undesirable conditions affecting the quality of work and the schedule.
- E. The quality assurance functions shall include, but not be limited to the following:
 - 1. Contract Review
 - 2. Factory and Field Testing
 - 3. Document Controls
 - 4. Handling and Storage
 - 5. Material Purchase
 - 6. Packaging and Shipping
 - 7. Shop Fabrication
 - 8. Quality Records
 - 9. Field Fabrication
 - 10. Non-Conformance
 - 11. Field Installation
 - 12. Corrective Action (s)
 - 13. Field Assembly
 - 14. Allocation of Responsibility and Authority
 - 15. Receiving Inspections
 - 16. Revocation of Authority



- 17. Final Inspection
- 18. Control of Activities
- 19. In-process inspections

- F. Promptly reject work which does not comply with requirements of the contract documents.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 60 00

PRODUCT OPTIONS

PART 1 GENERAL

1.01 DESCRIPTION

- A. This Section specifies minimum requirements for products, and substitutions.

1.02 QUALITY ASSURANCE

- A. Except as may be indicated in these Contract Specifications or on the Contract Drawings, furnish only new material for work under this Contract. The material shall be manufactured, handled, and used to ensure completed work in accordance with the Contract Documents.
- B. Compliance with Cited Standards:
1. Wherever the Contract Drawings require that materials and workmanship conform to specifically named codes or standards, provide in each instance materials and workmanship that meet or exceed the requirements of the latest edition of the specifically named codes or standards.
 2. Compliance with Product Standards: Where products are listed by Manufacturer it is intended only to establish a minimum standard in quality, functionality and performance and were selected for their open market availability and not intended to limit product options. If the Contractor wishes to use alternate products he shall submit a request for substitution to the City of Tempe or its representative.

1.03 SUBMITTAL

- A. Substitution Request Submittal:
1. Requests for Substitutions: Submit 2 (two) copies of each request for substitution. In each request identify the product to be replaced by the substitution, include related specification section. Include the following information, as appropriate, with each request:
 - a. Provide complete product data, drawings and descriptions of products.
 - b. Provide samples where applicable or requested.
 - c. Provide a detailed comparison of the significant qualities of the proposed substitution with those of the work originally specified.

Significant qualities include elements such as size, weight, durability, performance and visual effect where applicable.

- d. Provide complete coordination information. Include all changes required in other elements of the work to accommodate the substitution.
2. The Substitution request shall be accompanied by supporting documentation and comparisons to the specified product. and be submitted 10 or more days prior to the established bid date. Substitutions will not be permitted after the bids have been accepted.

1.04 REQUESTS FOR INFORMATION (RFIs)

- A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI to City of Tempe.
 1. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
 2. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
 3. Project name.
 4. Project number.
 5. Date.
 6. Name of Contractor.
 7. RFI number, numbered sequentially.
 8. RFI subject.
 9. Specification Section number and title and related paragraphs, as appropriate.
 10. Drawing number and detail references, as appropriate.
 11. Field dimensions and conditions, as appropriate.
 12. Contractor's suggested resolution. If Contractor's solution(s) impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
 13. Contractor's signature.
 14. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
 - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.



PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 70 00
PROJECT CLOSEOUT

PART 1 GENERAL

1.01 DESCRIPTION

- A. Definitions: "Closeout" is hereby defined to include general requirements which must be fulfilled near end of Contract Time, in preparation for Final Acceptance, final payment; normal termination of contract and similar actions evidencing completion of the work. Time of closeout is directly related to "Substantial Completion."

1.02 RELATED DOCUMENTS

- A. Requirements of the Agreement.
- B. Other specific requirements of the Agreement affecting closeout of the Project.

1.03 SUBSTANTIAL COMPLETION

- A. Prior to requesting the City of Tempe or its representative inspection and certification of Substantial Completion, the contractor shall complete the following:
 - 1. Obtain operational permits as may be required from the governing authorities enabling the Owner full and unrestricted use of the work and access to services and utilities.
 - 2. Deliver spare parts, extra stock of usable material and similar physical items as required by other sections of the Specifications.
 - 3. Remove all temporary facilities including storage trailers and unused material from the Project Site.
 - 4. Arrange for the manufacturer, installer and contractor's Project Manager to provide "on-site" complete instructions to City of Tempe personnel concerning proper operation and maintenance of each equipment or system. Provide to City of Tempe personnel Operation and Maintenance manual of each equipment and system.
 - 5. Provide photos before and after the construction of the staging area, each floor, and each elevator.
 - 6. Complete final "clean-up" of job site.
 - 7. Repair, restore or replace any damaged surfaces, material and

equipment. Leave work site clean, safe and in good order.

8. A substantial completion will be performed on each elevator and a punchlist will be developed.

1.04 PRE-REQUISITES TO FINAL ACCEPTANCE

- A. General: Prior to requesting the City of Tempe or its representative final inspection for Certification of Final Acceptance and Final Payment, as required by Contract, complete the following:
 1. Submit a copy to the City of Tempe or its representative stating that each item on issued on punchlist has been completed and dated by the Contractor.
 2. Submit Contractor's "Affidavit of Release of Liens".
 3. Provide all record documentation as required by formal certification letter stating that:
 - a. The contract work including all the punch list items have been satisfactorily completed.
 - b. All the required contract documents, spare parts, training etc as may be required in other sections of the specifications.
 - c. All warranty documents including documentation from the equipment manufactures that may exceed contract warranty. Provide registration confirmation with manufacturers.

1.05 REIMBURSEMENT OF COSTS

- A. The contractor shall be responsible for all costs incurred for the inspections related to "Substantial Completion" and "Final Acceptance" if extended more than once for each level of completion.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 73 29

CUTTING AND PATCHING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this section.

1.02 SUMMARY

- A. This Section includes procedural requirements for cutting and patching.
- B. See related sections include the following for specific requirements and limitations applicable to cutting and patching individual parts of the Work.

1.03 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of other Work.
- B. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

1.04 QUALITY ASSURANCE

- A. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.
- B. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.
- C. Miscellaneous Elements: Do not cut and patch miscellaneous elements or related components in a manner that could change their load-carrying capacity, that may result in reducing their capacity to perform as intended, or that may result in increased maintenance or decreased operational life or safety.

- D. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

PART 2 PRODUCTS

2.01 MATERIALS

- A. General: Comply with requirements specified in other Sections.
- B. In-Place Materials: Use materials identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
- C. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of in-place materials.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.
- B. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with in-place finishes or primers.
- C. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected

3.02 PREPARATION

- A. Temporary Support: Provide temporary support of Work to be cut.
- B. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas

3.03 PERFORMANCE

- A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
- B. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- C. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
- D. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces.
- E. Temporarily cover openings when not in use.
- F. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
- G. Concrete or Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
- H. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
- I. Proceed with patching after construction operations requiring cutting are complete.
- J. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections.
- K. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
- L. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.

- M. Clean piping, conduit, and similar features before applying paint or other finishing materials.
- N. Restore damaged pipe covering to its original condition.
- O. Cleaning: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

PART 4 INSERT SPECIFIC INSTALLATION REQUIREMENTS IF NOT SPECIFIED ELSEWHERE. SPECIFIC INSTALLATION REQUIREMENTS ARE BETTER SPECIFIED IN INDIVIDUAL SECTIONS.

END OF SECTION

SECTION 01 74 00

CLEANING AND WASTE MANAGEMENT

PART 1 GENERAL

1.01 DESCRIPTION

- A. Work included: Throughout the construction period, the Contractor shall maintain the work within the contract limit, in a standard of cleanliness as described in this Section.
- B. Related work: In addition to standards described in this Section, comply with requirements for cleaning as described in pertinent other Sections of these Specifications.

1.02 QUALITY ASSURANCE

- A. Conduct daily inspection, and more often if necessary, to verify that requirements for cleanliness are being met.
- B. In addition to the standards described in this Section, comply with pertinent requirements of governmental agencies having jurisdiction.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PROGRESS CLEANING

- A. General:
 - 1. Do not allow accumulation of scrap, debris, waste material and other items.
 - 2. Place all construction scrap material of any kind, type or nature into commercial containers on a daily basis.
 - 3. Daily, and more often if necessary, inspect the site and pick up all scrap, debris, and waste material.
 - 4. Weekly, and more often if necessary, and inspect all arrangements of materials stored on the site. Restack, tidy, or otherwise service arrangements to meet the requirements of subparagraph 3.01.A.1 above.

5. Maintain the site in a neat and orderly condition at all times.

3.02 FINAL CLEANING

- A. Prior to turning over the substantially completed project remove from the area all tools, surplus materials, equipment, scrap, debris, and waste.
- B. Visually inspect all existing and finished surfaces within the contract limits and remove all traces of soil, waste materials, smudges, graffiti and other foreign matter.
- C. Remove paint droppings, spots, stains and dirt from existing and finished surfaces.
- D. Finished Surfaces:
 1. Remove all labels and tags which are strictly used for the convenience of manufacturing, assembly, installation and identifications.
 2. Remove substances which are noticeable on surfaces.
 3. Clean stain steel surfaces of all foreign material
- E. Equipment:
 1. Wipe surfaces of all mechanical and electrical equipment including system components to a dirt-free condition. Touch up the surfaces to match with the overall finish of the equipment/system component.
 2. Verify that the equipment and system components are properly identified as required by the contract.

END OF SECTION

SECTION 02 41 00

DEMOLITION

PART 1 GENERAL

1.01 DESCRIPTION

- A. The work specified in this section consists of the demolition, removal, disposal and salvage of existing construction from the areas shown on the Contract Drawings and as required to execute the work of this Contract.
- B. Contractor will be responsible to remove demoed equipment for disposal.
- C. Provide a schedule for crane picks that will be required for demolition.

1.02 RELATED WORK:

- A. Summary of Work: Section 01 11 00.
- B. Specialty work as defined in various other divisions of the Specifications and the Contract Drawings.

1.03 REFERENCES

- A. Codes, Regulations, Reference Standards and Specifications:
- B. Codes and Regulations of the State of Arizona.
- C. ANSI - Standard Safety Code for Building Construction.
- D. OSHA - Standards as applicable.
- E. NFPA - 241 - Safeguarding Construction Alteration and Demolition Operations.

1.04 JOB CONDITIONS

- A. During the bid period, personally inspect and examine the construction site and existing construction to be removed and determine the type of demolition required or dismantlement procedure, physical conditions and any contingency that could be encountered during the demolition procedures.
- B. Existing conditions shown on the drawings are based on available plans and may not always reflect the actual field condition(s) due to unrecorded changes

or modifications. During the demolition work, verify and report actual field conditions prior to demolition work and record the conditions which will remain.

- C. Do not unduly inconvenience the general public and the City of Tempe employees by demolition activities.
- D. The City of Tempe does not assume any responsibility for the condition of any of the various structures or the loss of fixtures, equipment, materials or other objects.

PART 2 PRODUCTS

2.01 MATERIALS (NOT USED)

PART 3 EXECUTION

3.01 DEMOLITION AND REMOVAL

- A. General:
 - 1. Except as otherwise specified herein, demolish entirely and remove from the site all existing construction which interferes with new construction, is indicated on the Contract Drawings to be removed.
 - 2. Repair, replace or "dress-up" as required, surfaces adjacent to demolished areas that require such work as a result of the demolition work.
 - 3. Remove trash and debris daily unless otherwise directed by the Project Manager and do not allow waste materials to accumulate.
 - 4. Control and prevent the spread of dust to occupied portions of the site and avoid creation of a nuisance in the surrounding area.

3.02 DISPOSAL

- A. All materials resulting from demolition work shall become the property of the contractor and shall be removed from the limits of the City of Tempe's property for proper disposition in compliance with applicable laws and regulations.
- B. Legally dispose of debris off-site and in accordance with codes and regulations of the jurisdictional authorities

END OF SECTION

SECTION 02 41 15

ELECTRICAL DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Removal of existing electrical equipment, wiring, and conduit in areas to be remodeled; removal of designated construction; dismantling, cutting and alterations for completion of the work.
- B. Disposal of materials.
- C. Storage of removed materials.
- D. Identification of utilities.
- E. Removal of salvaged items.
- F. Protection of items to remain as indicated on drawings.
- G. Relocate existing electrical equipment to accommodate construction.
- H. Submit contractors and sub-contractors lockout/tagout procedures.

1.02 SUBMITTALS

- A. Submit the following in accordance with project submittal procedures:
 - 1. Shop drawings: indicate demolition and removal sequence and location of salvageable items; location and construction of temporary work. Describe demolition removal procedures and schedule.
 - 2. Project record documents: record actual locations of capped utilities, conduits and equipment abandoned in place.

1.03 REGULATORY REQUIREMENTS

- A. Conform to requirements of the National Electrical Code (NEC), OSHA, NFPA 70E – Standard for Electrical Safety in the Workplace.
- B. Each person performing electrical demolition shall be a “qualified person” as defined by NFPA 70E and the NEC.
- C. The following publications form a part of this specification to the extent referenced.
 - 1. Environmental Protection Agency (EPA).
- D. 40 CFR PART 761, Polychlorinated Biphenyls (PCBS) Manufacturing, Processing, Distribution In Commerce, And Use Prohibitions.

- E. 40 CFR PART 273, Standards For Universal Waste Management.
 - 1. U.S. Department Of Labor, Occupational Safety And Health Administration (OSHA):
- F. 29 CFR PART 1910.94 Subpart G, Occupational Health And Environmental Control.
 - 1. Department Of Transportation (DOT):
- G. 49 CFR PART 178, Regulations For Shipping Container Specifications.

1.04 COORDINATION

- A. Conduct demolition to minimize interference with adjacent building areas.
- B. Coordinate and sequence demolition so as not to cause shutdown of operation of surrounding areas.
- C. Shut-down periods:
 - 1. Arrange timing of electrical shut-down periods with the Project Electrical Engineer. Do not shut down any utility without prior written approval.
 - 2. Keep shut-down period to minimum or use intermittent period as directed by the Project Electrical Engineer.
 - 3. Maintain life-safety systems in full operation in occupied facilities or provide notice minimum 5 days in advance.
- D. Identify salvage items in cooperation with the City of Tempe.

PART 2 PRODUCTS

2.01 PRODUCT OPTIONS AND SUBSTITUTIONS

- A. Alternate products may be proposed for substitution. Refer to Section 01 60 00.

2.02 MATERIALS AND EQUIPMENT

- A. Provide materials and equipment for patching and extending work as specified in the individual sections.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Before work begins on the demolition or salvage of electrical equipment, wiring, or systems:

1. Inspect the site to identify any hazardous materials such as pcbs, asbestos, lead, mercury or other heavy metal, or toxic, flammable or explosive materials, or radioactive materials that may be handled, disturbed or removed. City of Tempe approved 3rd party testing company shall be utilized. Typical locations of hazardous materials include:
 - a. Lead: batteries in emergency luminaires, exit signs, fire alarm panels, security systems, ups systems, and some switchgear. Lightning protection components on some exhaust stacks. Lamp bases
 - b. PCBS: oil-filled transformers; potting material and/or capacitors in lighting ballasts; oil-filled capacitors associated with motors, ups systems, voltage regulators, power-factor correction equipment
 - c. Asbestos: pipe insulation, electrical insulation
 - d. Mercury: fluorescent lamps, hid lamps, thermostats, “silent” wall switches, some “silent” enclosed relays
 - e. Radioactive materials: self-luminous exit signs, smoke detectors.
 2. Verify whether or not pcb ballasts exist in light fixtures which will be removed or relocated. If pcb light fixture ballasts exist, notify Project Resident Electrical Engineer and owner for method of disposal. Follow federal disposal guidelines when dealing with PCB's.
 3. Have the inspection results available at the worksite, including any drawings, plans or specifications, as appropriate, to show the locations of any hazardous substances.
 4. Ensure that any hazardous materials found are safely contained or removed.
 5. During demolition work, if hazardous materials are discovered that were not identified in the initial inspection required above, stop work in the area and notify the project electrical engineer. Do not resume work in the area until directed by the Project Electrical Engineer.
- B. Verify wiring and equipment indicated to be demolished serve only abandoned facilities.
- C. Verify termination points and lockout-tagout device locations for services, circuits, and systems to be disconnected or removed.
- D. Demolition drawings are based on casual field observation and/or existing record documents. Report discrepancies to the project electrical engineer before beginning demolition work.

- E. Beginning of demolition work means subcontractor accepts existing conditions.

3.02 PREPARATION

- A. Protect existing materials, appurtenances and equipment which are not to be demolished. Repair or replace existing materials, appurtenances and equipment, building exterior and interior, and landscaping altered or damaged during demolition work to match existing undisturbed conditions at no additional cost to the Owner.
- B. Erect, and maintain temporary safeguards, including warning signs and lights, for protection of the public, Owner personnel, subcontractor's employees, and existing improvements to remain.
- C. Provide temporary egress signage and emergency lighting to meet life safety code requirements.
- D. Provide and maintain temporary weather protection during interval between demolition and removal of existing construction on exterior surfaces and installation of new construction to ensure that no water leakage or damage, or wind damage occurs to structure or interior areas of existing building.
- E. Maintain parking areas, driveways, exterior walkways, exit paths, and landscaping in a clean, undisturbed condition.
- F. Coordinate utility service outages with the Project Electrical Engineer.
 - 1. Request underground utilities to be located and marked within and surrounding construction areas.
 - 2. All work on or near energized electrical utilities will be performed or supervised Project Electrical Engineer.
 - 3. Protect utilities indicated to remain, from damage.
- G. Protect smoke detectors from dust intrusion.
- H. Provide temporary wiring and connections to maintain existing systems in service during construction. In particular, security systems, safety class systems, safety significant systems, and life safety systems must be maintained in operation at all times. This includes security and safety lighting.
- I. Existing medium-voltage utility system: protect existing medium-voltage (e.g. 13.2 kv, 2.4 kv) utility equipment (e.g. Utility transformers, switchgear, cables, ductbanks and manholes). Do not disturb or operate medium-voltage utility systems or equipment. Coordinate utility shutdowns or equipment removal with the Project Electrical Engineer.

- J. Existing low-voltage electrical service: maintain existing low-voltage (e.g. 480 v, 208 v) electrical service system in operation until new service system is complete and ready for operation. Disable service system only to make switchovers and connections. Obtain permission through the project electrical engineer at least three (3) working days before partially or completely disabling system. Minimize outage durations. If required, make temporary connections to maintain service in areas adjacent to work area.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Demolish, relocate, and extend existing electrical work to installations to accommodate new construction.
- B. Establish an electrically safe work condition in areas where electrical work is to be removed.
 - 1. Comply with electrical safety program.
 - 2. Comply with *lockout/tagout for hazardous energy control*. Disconnect or shut off service to areas where electrical work is to be removed. Properly lockout and tag disconnecting means. Verify zero-voltage before beginning demolition.
 - 3. Disconnect, remove, and cap designated utility lines within demolition areas. Mark locations of disconnected utilities. Identify utilities and indicate capping locations on project record documents.
- C. Protect and retain power to existing active equipment that is to remain.
 - 1. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.
 - 2. Install temporary wiring and connections to maintain existing systems in service during construction.
- D. Carefully remove equipment, materials, or fixtures which are to be reused. Store and protect to prevent damage.
 - 1. Disconnect, remove, or relocate existing electrical material and equipment interfering with new installation.
- E. Remove electrical fixtures, equipment, and related switches, outlets, conduit and wiring which are not part of final project.
 - 1. Remove items in an orderly and careful manner.
 - 2. Remove abandoned wiring to panelboard circuit breaker or source of supply.
 - 3. Remove exposed abandoned raceways, including abandoned raceways above accessible ceiling finishes. Cut raceways flush with walls and floors, seal openings, and patch surfaces.
 - 4. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.

5. Remove abandoned cable tray systems.
6. Disconnect and remove abandoned panelboards and distribution equipment.
7. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
8. Remove exposed abandoned fasteners and supports, including abandoned components above accessible ceiling finishes. Cut embedded support elements flush with walls and floors.
9. Cap abandoned empty conduit at both ends.
- F. Provide proper and permanent support to adjacent structure for all raceways, cable trays, luminaires, and equipment to remain.
- G. Repair adjacent construction and finishes damaged during demolition and extension work.
 1. Patch and seal unused existing wall penetrations to match existing conditions and to restore fire rating.
- H. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified. This includes the extension of the circuit from the last active device to the next device in the system to be activated.
 1. Reconnect equipment being disturbed by renovation work and required for continued service to nearest available panel.
- I. Investigate and measure the nature and extent of unanticipated items that conflict with intended function or design. Submit written report with accurate detailed information to the project electrical engineer. While awaiting instructions from the project electrical engineer, rearrange selective demolition schedule as necessary to continue overall job progress without delay.
- J. Stop work and notify the project electrical engineer immediately if structure or other items to remain appear to be endangered. Do not resume work until directed by the Project Electrical Engineer.
- K. Remove demolished materials as work progresses.

3.04 EXISTING ELECTRICAL DISTRIBUTION EQUIPMENT

- A. Verify and identify loads served by circuits in existing electrical distribution equipment (e.g. Switchgear, motor control centers, panelboards) affected by the work. Where additional circuits are needed, reuse circuits available for reuse. Install new circuit breakers as required.

- B. Tag unused circuits as spare.
- C. Where existing circuits are indicated to be reused, use measuring devices to verify circuits feeding project area are not in use.
- D. Remove existing wire no longer in use from distribution equipment to equipment.
- E. Re-label circuit breakers, switches, and controllers to indicate loads served. Provide new, updated circuit directories where more than three circuits in a panelboard have been modified or rewired.

3.05 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment which remain or are to be reused.
- B. Electrical distribution equipment: clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide approved closure plates for vacant positions.
- C. Luminaires: remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts (if required) and broken electrical parts. Test for proper operation.

3.06 DISPOSITION OF MATERIAL AND EQUIPMENT

- A. Remove and protect items indicated on drawings to be salvaged and deliver in good condition to project resident electrical engineer at the location designated.
- B. Items of salvageable value may be removed as work progresses. Transport salvaged items from site as they are removed.
- C. Unless indicated otherwise, material removed under this subcontract which is not to be salvaged or reused in the project shall become the property of the subcontractor.
- D. Unless indicated otherwise, immediately remove demolished material from site. Do not store or permit debris to accumulate at the site. Dispose of materials legally off site. Do not burn or bury materials on site.
- E. Upon completion, clean the entire area of demolition residue satisfactory for the continuation of the work. Remove temporary work.

END OF SECTION

SECTION 14 24 10

HYDRAULIC PASSENGER ELEVATOR - MODERNIZATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Condition, and Division 1 Specification Sections, and Division 2 Specifications Sections, and the Contract Drawings, apply to this Section.

1.02 SUMMARY

- A. The scope of work consists of the modernization of two (2) in-ground hydraulic passenger elevators located at the Tempe 525 Building. The elevators consist of a rated capacity of 3,500 lbs. and a rated speed of 150 fpm serving three (3) stops with three (3) openings. While specifications address requirements for standards, it is of utmost importance that all existing elevator equipment retained during the modernization is made to operate as new, tested, warranted and guaranteed as if new.
- B. The Contractor is to ensure that all work is performed in accordance with the requirements of federal, state and local codes and regulations, which govern the requirements of the work specified. All equipment, design, clearances, construction, operation and tests are required to be in accordance to ASME/ANSI A17.1 – 2007 Safety Code for Elevators Escalators and all pertinent codes, regulations and rules being enforced by the State of Arizona Elevator Inspection Division at time of award and permitting.
- C. The Contractor is required to perform thorough field surveys in addition to providing all engineering, labor, materials, storage, tools, equipment, supervision and transportation in order to fulfill the requirements for design, engineering, fabrication, and installation of the elevator equipment in a complete first-class manner and in accordance with the requirements of the contract documents.
- D. Whenever a reference is made to a part of the equipment being provided in a singular number, it applies to as many such items that may be required to provide a complete installation.
- E. Any equipment not specifically identified within the contract documents but that is essential to the installation and operation of the equipment specified herein is to be provided by the Contractor as if the same was identified in the specification.

- F. Specifications indicate the arrangement of the elevator work to be provided. The Contractor is to carefully review these documents along with field conditions, as the Contractor will be responsible for the proper fitting and installation of the equipment specified. Should a conflict exist the Contractor is required to submit details of such conflict prior to the submission of the bid proposal. There will be no departures from the contract documents without prior written approval.
- G. The Contractor is responsible to make provisions for all transportation, storage, handling, receiving, hoisting and removal of equipment from the project property.
- H. The Contractor shall perform all demolition of the equipment and to provide required cutting, alterations, and removal as may be required to accommodate the installation of the equipment specified.
- I. The Contractor shall comply with all requirements of the NFPA Code. The Contractor shall provide a fire watch in the area of all burning and welding for a minimum of two (2) hours after the completion of the activity. The Contractor must obtain written permission of the Owner prior to commencing with any burning or welding. Contractor shall file a hot work permit with the Designated Representative and provide a minimum 24-hour notice for fire system isolation for all burning and welding.
- J. Any damage to the existing structure and finishes incurred during the performance of this work will be the responsibility of the Contractor to restore in a manner that meets with Owner's approval.
- K. The Contractor is responsible for keeping the project premises clean at all times during the performance of the work. All removed and demolished equipment must be removed from the project premises on a continual basis.
- L. All equipment is to be delivered in the manufacturer's original unopened protective packaging.
- M. Contractor is responsible to provide warehousing as required to accommodate all equipment that will be manufactured for this project. Warehousing is to be fully insured and bonded. Ensure that storage provides for the prevention of physical damage of the elevator equipment. Provisions are to be in place for access as may be deemed required by the Owner.
- N. Mandatory warehouse inspection – The elevators will not be released to the contractor without verification by the Consultant that all material required to perform the work specified in the contract documents is located in the Contractor's warehouse, specifically labeled for this project, and free from any physical damage readily evident by visual inspection. Upon successful

completion of the warehouse inspection, the Contractor will be permitted to remove the elevator from public use.

- O. In addition to providing required protection of stored material, the Contractor is required to fully protect the elevator equipment and hoistway at all times during the performance of modernization program. Provide and maintain required barricades noted in specifications. Proper signage information is required on all barriers.
- P. The Owner is not responsible for materials, equipment or tools of the Contractor and will not be liable for any loss or damage thereof.
- Q. Contractor is to provide any and all information as required for the appropriate coordination of work to be performed by other trades. Address any possible impacts on the installation schedule.
- R. Completion of the elevator work requires of the Contractor to have the equipment completely inspected in accordance with the specifications in order to demonstrate that the equipment, as installed, conforms to the specifications and code requirements. All labor, tools and equipment necessary to conduct the onsite inspections and testing are the responsibility of the Contractor. The elevator will be inspected by the Consultant prior to the State of Arizona Elevator Inspection.
- S. The Contractor has no advertising privileges related to this project unless specific written permission is obtained from the Owner. Contractor is required to maintain the work area free from any and all posters, signs and decorations. Contractor's name, trademarks, logos or other identifying symbols are not to appear on any surface visible to the general public.
- T. Contractor is responsible for the safety of his workers and any occupants for the duration of the project and as a minimum the Contractor must adhere to OSHA Standards. Contractor is required to submit for approval a safety plan that illustrates the standards and procedures to be adhered to throughout this project.
- U. Related Specified Work Performed by Contractor and other Trades:
 - 1. Wire from all disconnects to the elevator control panels is the responsibility of the contractor.
 - 2. Bevel any cants or setbacks required on side or rear walls and beams that project four (4) or more inches.
 - 3. Cutting and patching of existing walls to facilitate the installation of signal and operating devices as applicable.
 - 4. Fire safe all penetrations in the elevator hoistways that currently exist and those that may be created during the course work.
 - 5. Upgrade lighting in all machinery and overhead spaces.

6. Modify hoistway and machine room ventilation where necessary to meet current code requirements.

1.03 REFERENCES

A. Applicable Codes and Standards:

1. All codes and standards adopted by the State of Arizona and the State of Arizona Elevator Inspection Division in affect at the time of contract award.

1.04 DEFINITIONS

A. The following definitions apply to work of this Section:

1. Provide: to furnish and install, complete for safe operation, unless specifically indicated otherwise.
2. Install: to erect, mount and connect complete with related accessories.
3. Supply: to purchase, procure, acquire and deliver complete with related accessories.
4. Work: labor and materials required for proper and complete installation.
5. Wiring: raceway, fittings, wire, boxes, and related items.
6. Concealed: embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces or in enclosures.
7. Exposed: not installed underground or concealed as defined above.
8. Indicated, shown or noted: as indicated, shown or noted on Drawings or as specified.
9. Similar, or equal: of base bid manufacturer, equal in materials, weight, size, design and efficiency of specified product, conforming to acceptable manufacturers.
10. Reviewed, satisfactory, accepted, or directed: as reviewed, satisfactory, accepted or directed, by or to Owner.

1.05 SUBMITTALS

A. Shop Drawings and Samples: Provide four (4) complete sets of shop drawings. Include layouts of pits, machine rooms, power and heat data and required clearances.

1. Provide shop drawings and descriptive literature/catalog cuts of all equipment and components.
2. Coordination information meeting electrical requirements.
3. Specifications indicate the general arrangement of the elevator work.
4. Contractor shall carefully review this documentation along with existing field conditions and shall be responsible for the proper fitting of the equipment and material indicated.
5. Provide one (1) set of drawings in electronic format utilizing a USB Flash Drive.

- B. Owner/Service Manuals: Prior to installation, Contractor shall submit two (2) sets of operation and maintenance manuals for approval. After approval and prior to the beginning of acceptance testing, four (4) sets in hardcopy and one (1) set in electronic format (USB Flash Drive) of the approved manuals shall be provided by the Contractor. The manuals shall include the following:
1. Equipment and components, descriptive literature.
 2. Performance data, model number.
 3. Installation instructions.
 4. Operating instructions.
 5. Maintenance and repair instructions.
 6. Troubleshooting techniques.
 7. Spare parts lists and current price list.
 8. Lubrication instructions.
 9. Detailed, record and as-built layout drawings.
 10. Detailed, simplified, as-built, one line, wiring diagrams. Provide one (1) complete set per manual.
 11. Field test reports.
 12. Complete set of contract software.
 13. Twelve (12) keys for each new key-operated device that is provided and with a metal tag identifying number of the elevator and purpose of key.
 14. Diagnostic tools configured to perform at all levels.
 15. The contractor will provide certification, in writing and signed by an officer of the organization, that the Owner of the elevator shall be provided with copies of any and all information, correspondence, bulletins, newsletters, manuals, techniques, procedures, drawings, sketches and any other documents related to maintenance, safety, operations, design changes, modifications, retrofits, etc., which relate to any part, component, equipment, system, subsystem or material and services applicable to the elevator provided.
 16. The required items in the above-mentioned certification shall be provided as it pertains to the original installation and for a period of ten (10) years after final acceptance of the elevator.
 17. The reference material shall be provided within thirty (30) days of publication or internal distribution by the elevator manufacturer. The material, even if labeled PROPRIETARY, shall be delivered to the Owner without prejudice or delay and at no additional cost.
 18. The entire manual shall also be provided in electronic format on CD-ROM.
- C. Machine Room Prints: Provide complete sets of "as- built" field wiring and straight-line wiring diagrams showing all electrical circuits in the hoistway as well as the machine room. These diagrams shall be laminated and provided in the elevator machine room as directed.
- D. Provide one (1) set of "as-built" drawings in electronic format utilizing a USB Flash Drive.

1.06 QUALITY ASSURANCE

- A. Quality and gauges of materials:
 - 1. New, best of their respective kinds, free from defects.
 - 2. Materials, equipment of similar application; same manufacturer, except as noted.
 - 3. Gauges as noted.

1.07 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Ship in original crated sections of a size to permit passage through available space.
- B. Obtain approval and schedule delivery of material to meet Owner's requirements.
- C. Storage of equipment and materials shall be coordinated with Owner.
- D. Removal of Rubbish and Existing Equipment
 - 1. On a scheduled basis the Contractor shall remove from the job site all rubbish generated in performing work specified in the contract documents.
 - 2. Any component of the existing elevator that is not reused under the scope of work shall become the property of the Contractor and as such shall be removed from the premises at the Contractor's sole expense.
 - 3. The Contractor agrees to dispose of the aforementioned equipment and rubbish in accordance with any and all applicable Federal, State and municipal environmental regulations. The Contractor further accepts all liability that may result from handling and/or disposing of said material. Documentation of proper disposal is to be provided to the Owner.

1.08 WARRANTY

- A. Material and workmanship of installation shall comply in every respect with Contract Documents. Correct defective material or workmanship which develops within one (1) year from date of Substantial Completion of all elevators under this contract to satisfaction of the Owner at no additional cost, unless due to ordinary wear and tear, or improper use or care by the Owner.
- B. Defective is defined, but not limited to; operation or control system failures, car performance below required minimum, excessive wear, unusual deterioration or aging of materials or finishes, unsafe conditions, need for excessive maintenance, abnormal noise or vibration, and similar unsatisfactory conditions.
- C. Make modifications, requirements, adjustments and improvements to meet performance requirements in Parts 2 and 3.

1.09 MAINTENANCE SERVICE

- A. All elevators identified in Section 1.02 A shall be maintained by the Vertical Transportation contractor upon receipt of the NTP thru the expiration of the warranty period of all elevators. Maintenance shall include periodic (semi-monthly) inspection, cleaning, lubrication and adjustment, in compliance with the contractors published Maintenance Control Program. Any testing, including monthly fire service test and ASME A17.2 periodic requirements that become due during the interim and warranty maintenance period are to be included at no additional cost to the Owner. Provide 24hr callback service at no additional cost to the Owner with a response time not to exceed one (1) hour during normal working hours. Normal working hours of the elevator industry are from 8:00AM to 4:30PM Monday through Friday. Two (2) hour response before or after normal hours. Response time for emergencies shall be thirty (30) minutes.
- B. Diagnostic Tools and Spare Parts: At the completion of the work as specified, the Contractor shall provide items listed. These items shall become the Owner's property.
 - 1. One (1) complete set of all diagnostic tools and equipment required for the complete maintenance of all aspects of the control and dispatch system and solid-state motor drive units. The diagnostic system shall be an integral part of the controller and provide user-friendly interaction between the serviceman and the controls. All such systems shall be free from secret codes and decaying circuits that must be periodically reprogrammed by the manufacturer. Diagnostic equipment shall be permanently mounted in the control cabinet or secured in a lock cabinet provided by the contractor and located within the elevator machine room.
 - 2. A list of vendors for all parts used in the installation.
 - 3. A service cabinet shall be installed in the machine room to store diagnostic tools and material. The Owner shall have key to cabinet.
- C. Training to Owner/Service Company.
 - 1. See Section 3.3. – Instructions and Demonstration to Owner

1.10 ELECTRIC SERVICE

- A. Power: 480 volts, 3 phase, 60 hertz. (To be verified by Contractor)
- B. Lighting: 110 volts, 1 phase, 60 hertz. (To be verified by Contractor)

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Product of individuals, firms or corporations regularly engaged in modernizing elevators comparable with this contract and in satisfactory operation for a period of not less than five years. Contractor must have an office within one (1) hour drive of the Project. There shall be no logos or contractor/manufacturer's identification or nameplates within the elevator car or hallways.
- B. Should a conflict exist between the specifications, drawings or field conditions, the Contractor shall submit details of such conflicts prior to the bid proposal submission. No departures will be allowed without prior written approval. Any substitutions to the specified product must be presented prior to the submission of a bid proposal and with the understanding that no substitutions will be allowed after contract award.

2.02 MATERIAL

- A. Except where product conformance to specific standards is indicated on the Contract Drawings and in ASME A17.1-2007, manufacturer's standard materials and equipment may be used in elevator construction, subject to approval. Materials cited below are intended to establish the standard of quality for comparable materials used by the manufacturer.
- B. Structural Shapes, Plates, Sheets, and Tubing: ASTM A36 Steel.
- C. Sheet Steel: ASNI/ASTM A446, Grade B.
- D. Stainless Steel: ASTM A167, Type 304, with No. 4 finish.
- E. Aluminum: ASTM B211 or ASTM B221, Alloy 6061, T6.
- F. Flooring: To Be Determined. Installed by Contractor.

2.03 OUTLINE OF EQUIPMENT

- A. Hydraulic Passenger Elevators
 - 1. Designation: Elevator #1 & #2
 - 2. Elevator Use: Passenger
 - 3. Capacity: 3,500 pounds
 - 4. Contract Speed: 150 fpm
 - 5. Travel: 30'-6-1/2" (VIF)
 - 6. Number of Stops: Three (3)
 - 7. Number of Openings: Three (3) Front
 - 8. Machine Location: Adjacent to Hoistway

- | | |
|--|---|
| 9. Machine Type: | New - Submersible Hydraulic |
| 10. Direct Plunger Hydraulic Jacks: | In-ground; Retain/Repack |
| 11. Controller: | MCE Hydraulic Controller or Approved Equal |
| 12. Landing System: | New |
| 13. Platform Size: | Reuse Existing |
| 14. Car/Hoistway Door Size: | 42" W X 84" H |
| 15. Car Door Type: | New - Single Speed Center Opening |
| 16. Hoistway Door Type: | Retain - Single Speed Center Opening |
| 17. Door Guide Assembly: | SEES Enforcer or Approved Equal |
| 18. Entrance Frames: | Retain |
| 19. Door Operation | Retain - GAL / MOVFR |
| 20. Door Reversal Device: | Janus Panachrome 3D Light Screen |
| 21. Car Roller Guides: | New ELSCO or Approved Equal |
| 22. Guide Rails: | Retain – Clean, Realign and Paint |
| 23. Buffers: | Spring Type - Retain and Paint |
| 24. Cab Enclosure: | New Cab Interior to be determined,
Assume \$25,000 Cab Interior Upgrade
Allowance |
| 25. Car Operating Panels: | New full swing return by Innovations
Industries |
| 26. Car Position Indicator: | New – Digital integral with car operating
panel |
| 27. Hall Call Stations: | New – by Innovations |
| 28. Hall Lanterns: | New - Digital |
| 29. Communication System: | Hands-free ADA Telephone integral with
car operating panel |
| 30. Additional Features: | |
| a. Emergency Cab Lighting integral with Car Operating Panels | |
| b. New - Hoistway Access Control at Top and Bottom Landings | |
| c. Tamper Resistant Fasteners at all Fixtures | |
| d. Car Operating Panels swing panels shall have a minimum of 3/8" clearance above finish floor or proper clearance above finish floor. | |
| e. Oil return scavenger pump/collection system in pit. | |

2.04 MACHINE ROOM EQUIPMENT

- A. Submersible Pump Unit: The storage tank shall be constructed of 12-gauge steel and shall be provided with a removable cover containing a removable oil dip stick. The pump and submersible motor shall be mounted on a special reinforced isolation mount. The control valve shall be mounted in the discharge line above the oil level and easily accessible from the top of the tank. An air-bladder silencer shall be provided at the control valve discharge. Provide all initial supply of oil sufficient for proper operation. Hydraulic oil shall be biodegradable hydraulic fluid of ISO grade suitable for the performance requirements as specified herein as supplied by Hydro-Safe or approved

equal. Pump unit shall not be installed directly under existing mechanical water pipes in machine room.

- B. Motor: The motor shall be of the alternating current, poly-phase squirrel cage induction type and shall be of a design especially adapted to electro-hydraulic requirements.
- C. Pump: The pump shall be a positive displacement screw type to give smooth operation and shall be especially designed and manufactured for elevator service.
- D. Control Valve: The control valve shall be manifold with up, down and check valve sections. A control section including solenoid valves will direct the main valve and control up and down starting, transition from full speed to leveling speed, up and down stops, pressure relief and manual lowering. Down speed and up and down leveling shall be controlled at the main valve sections. All of these functions shall be fully adjustable for maximum smoothness and to meet contract conditions. The manual lowering feature will permit lowering the elevator at slow speed in the event of power failure or for adjusting purposes.
- E. Controller: The elevator controller shall be microprocessor based and designed specifically for elevator applications. Elevator and drive logic shall be implemented independently of safety functions. Elevator logic shall be implemented to facilitate tight coordination between subsystems and enhance reliability. The implementation shall utilize a real-time, multi-tasking operating system to allow the processors to simultaneously execute elevator control logic, drive control logic, operator interface logic, and communication support. The elevator controller shall have an independent safety system in order to implement safety features required by code.
 - 1. The control system shall provide comprehensive means of accessing the computer memory for elevator diagnostic purposes. It shall have permanent indicators for important elevator status conditions as an integral part of the controller.
 - 2. The microprocessor boards shall be equipped with on-board diagnostics for ease of troubleshooting and field programmability of specific control variables. Field changes shall be stored permanently, using nonvolatile memory. The microprocessor board shall provide the features listed below:
 - a. On-board diagnostic switches and an alphanumeric display to provide user friendly interaction between the mechanic and the controller.
 - b. An on-board event log shall store and display time-stamped events for diagnostic purposes. An on-board real time clock shall display the time and date and be adjustable by means of on-board switches.

- c. Field programmability of specific timer values (i.e., door times, valve limit times, etc.) may be viewed and/or altered through on-board switches and pushbuttons.
3. The elevator controller shall have extensive diagnostic capability. A built-in LCD display or equivalent shall allow access to major user functions and diagnostic features. The display shall be a multi-character, multi-line type with associated keypad to allow users to enter information. The display shall show data and menus in readily understood character format. Numeric, hexadecimal, or binary codes are not acceptable.
 - a. Dedicated indicators shall be provided in a conspicuous location on the elevator controller to indicate important system statuses, such as when the safety string is made, when the door locks are made, when the elevator is on Inspection or Access, etc. In addition, other special or error conditions detected by the main processor or safety subsystem shall be displayed.
4. Circuit boards within the controller shall communicate through CAN Bus connections for reliable performance and simplified board replacement. Power for individual circuit boards shall also be distributed through the CAN Bus connection. Communication and power connection shall radiate from a central, multi-connection point such that single-point board failure shall not affect operation of other boards.
5. Field I/O boards shall be universal in that 24V to 120V AC or DC connections shall be accepted without requirement for unique circuit boards for each. I/O boards shall provide built-in current limiting protection.
6. Failure of any single magnetically operated switch, contactor, or relay to release in the intended manner; the failure of any static control device, speed measuring circuit, or speed pattern generating circuit to operate as intended; the occurrence of a single accidental ground or short circuit shall not permit the car to start or run if any hoistway door or gate interlock is unlocked or if any hoistway door or car door or gate contact is not in the made position. Furthermore, while on car top inspection or hoistway access operation, failure of any single magnetically operated switch, contactor or relay to release in the intended manner, failure of any static control device to operate as intended or the occurrence of a single accidental ground, shall not permit the car to move even with the hoistway door locks and car door contacts in the closed or made position.
7. Dedicated permanent status indicators shall be provided on the controller to indicate when the safety string is made, when the door locks are made, when the elevator is operating at high speed, when the elevator is on independent service, when the elevator is on Inspection or Access, when the elevator is on fire service, when the elevator out of service timer has elapsed, and when the elevator has failed to successfully complete its intended movement. A means shall be provided to display other special or error conditions detected by the microprocessor. Every field connection

- input or output shall have a dedicated LED such that no volt meter or other test equipment is required to see when and input or output is active.
8. An out of service timer (T. O. S.) shall be provided to take the car out of service if the car is delayed in leaving the landing while calls exist in the system.
 9. Motor limit timer function shall be provided which, in case of the pump motor being energized longer than a predetermined time, shall cause the car to descend to the lowest landing and park, open the doors automatically, and then close them. Calls shall be appropriate canceled and the car taken out of service automatically. Operation may be restored by cycling the main line disconnect, putting the car on inspection operation, or pressing the Fault Reset button. Door reopening devices shall remain operative.
 10. A valve limit timer shall be provided which shall automatically cut off current to the down valve solenoids if they have been energized longer than a predetermined time. Calls shall be appropriate canceled and the car taken out of service automatically. Operation may be restored by cycling the main line disconnect, putting the car on inspection operation, or pressing the Fault Reset button. Door reopening devices shall remain operative.
 11. Car and hall call registration and lamp acknowledgment shall be by means of a single wire per call, in addition to the ground and the power bus. Systems that register the call with one wire and light the call acknowledgment lamp with a separate wire can be accommodated. The user shall be able to register car calls via the on-board LCD display and keypad.
 12. Fire Phase I emergency recall operation, alternate level Phase I emergency recall operation and Phase II emergency in car operation shall be provided according to applicable local codes.

2.05 OPERATING SYSTEMS

- A. Selective Collective Control: Provide selective collective operation as defined by ASME A17.1.
- B. Independent Service: Provide controls to remove elevator from normal operation and provide control of the elevator from car buttons only. Car shall travel at contract speed and shall not respond to hall calls.
- C. Car Top Operation: Provide new inspection and maintenance control station mounted on the car top. The station is to include up and down buttons, inspection operation button, and stop switch, GFI duplex outlet, permanently mounted work light and guard along with audible and visual signal to comply with fire service control.

- D. Emergency Recall Operation (Fire Service): Provide operation and equipment per Code requirements. Provide a three-position key switch, marked "RESET-OFF-ON", at the main fire egress lobby. Any additional switches for control panels of alternate recall floors are to be two-position, marked "OFF-ON". The elevator is to be provided with Phase II operation. Elevator Contractor shall provide relays, wiring, and terminal strips to receive signals from ionization detectors. Elevators to be provided with house number above door jamb main egress landing. Sign to match existing finish.
- E. Emergency Car Lighting and Alarm System: Unit shall provide emergency LED light in car upon failure or interruption of normal car lighting. Emergency lighting unit shall provide a minimum illumination of 0.2 foot-candle at 4 feet above car floor approximately one (1) foot in front of car operating panel for not less than 4 hours. Emergency lighting in each COP. Battery shall be 6-volt minimum, sealed rechargeable lead acid or equal. Battery charger shall be capable of restoring battery to full charge within sixteen (16) hours after resumption of normal power. Provide an external means for testing battery, lamps, and alarm bell.

2.06 OPERATION PERFORMANCE

- A. The control system shall provide smooth acceleration and deceleration with $\frac{1}{4}$ " leveling accuracy at all landings, from no load to full rated load in the elevator, under normal or unloading conditions. The self-leveling shall, within its zone, be entirely automatic and independent of the operating device and shall correct for over-travel and under-travel. The car shall remain at the landing irrespective of load. Clearance between the car sill and the hoistway landing shall not exceed $1 \frac{1}{4}$ inch.
- B. The door open time for elevators is not to be less than 3.0 fps.
- C. The door close time shall be based on the Code requirements with a door delay feature. The door delay is the minimum acceptable time from notification that a car is answering a call (lantern and audible signal) until the doors of the car start to close. Time shall be calculated by the following equation:
1. $T = D / (1.5 \text{ ft/s})$
 2. $T =$ Total time in seconds.
 3. $D =$ Distance from a point in the lobby sixty (60) inches directly in front of the hall station to the centerline of the door opening.
- D. Car Call: The minimum acceptable time for doors to remain fully open shall not be less than 5 seconds.
- E. The speed of the elevator shall not vary +/- 5% under loading conditions.

- F. The elevator is to be statically and dynamically balanced. With empty car, maximum pressure on any roller guide shall not exceed ten (10) pounds, with the elevator located at any point in the hoistway.

2.07 HOISTWAY EQUIPMENT

- A. Guide Rails: Car -Planed steel, standard T-sections. Existing guide rails are to be retained. The rails and brackets are to be examined and re-secured as necessary. The machined surfaces of the rails are to be thoroughly cleaned. All rail joints shall be filed smooth and the alignment checked and adjusted as necessary to within 1/8" top to bottom and face-to-face. The un-machined portion of the rails are to be cleaned and painted.
- B. Car Roller Guide Assemblies: Roller guide assemblies of the size and type required for the applicable application shall be mounted on top and bottom of the car to engage the guide rails. As a standard of quality provide type Model B as manufactured by Elevator Safety Company (ELSCO).
- C. Pit Channels and Car Buffers: Retain/Reuse pit channels. Clean, paint and recondition to new.
- D. Pit Ladder: Provide a new pit ladder extending 48" above the bottom landing sill and located on the access side of the hoistway for compliance with ASME/ANSI A17.1.
- E. Stop Switch: A new stop switch, mounted in the pit in a NEMA 4 rated enclosure shall prevent operation of elevator when switch is activated.
- F. Terminal Limits; New limit switches shall slowdown and stop the car at the terminals if the primary automatic stopping system fails.

2.08 WIRING:

- A. Conductors: Provide copper insulated wiring with flame retarding and moisture resisting outer cover. Install in galvanized metal wire-ways and raceways. Conductors from shaft riser to door interlocks shall be SF-2 type or equal, maximum operating temperature 392 degrees F. All terminations shall be insulated to maintain integrity of wiring. Flexible conduit may be used for short connections. Provide 10% spare conductors throughout.
- B. Traveling Cables: UL labeled fire and moisture resistant outer braid and steel supporting strand. Provide four pairs of shielded communication wires and car lighting circuits. Prevent cables from rubbing or chafing against hoistway or car items.
- C. Provide five (5) pair of shield wires and two (2) RG-59 type coaxial cables.

- D. Work Light and Duplex Receptacles: Provide on top and bottom of car with 110volt GFI receptacle and work light with guard.

2.09 JACK HOLE AND CASING

- A. Retain/Reuse existing Jack hole and Casing.

2.10 IN-GROUND TYPE HYDRAULIC ELEVATOR

- A. Jack Assembly: Retain/Reuse existing. Provide new packing gland.
- B. Provide a positive displacement, rotary type oil return scavenger pump. Mount the scavenger pump off the pit floor and connect it to the jack unit and the oil tank with copper tubing.

2.11 HYDRAULIC PIPING AND APURTENANCES

- A. All existing piping shall be replaced with new per the following:
 - 1. Pipe and Fittings: Provide piping sizes recommended by elevator pump unit manufacturer and provide isolation couplings to prevent sound/vibration transmissions from power unit. Hydraulic oil piping shall be ASTM A53, standard weight Schedule 40 pipe with extra heavy malleable iron, 300 WSP fittings. Victaulic fittings are not permitted.
- B. Muffler: Provide a blow-out-proof muffler in the oil line between the hydraulic power unit and jack assembly. Muffler shall reduce pulsation and noise originating from power unit. Muffler shall be easily accessible for inspection of interior parts without removing the housing from the oil line.
- C. Provide a 40-mesh strainer in the suction line between the tank and pump. Strainer shall be sufficiently sized for low-pressure drop.
- D. A code compliant ball pit shut off valve shall be provided in the machine room and elevator pit.
- E. A rupture valve to comply with Seismic requirements shall be provided in the pit if required.
- F. Oil return scavenger pump/collection unit shall be provided in the elevator pit so located to not interfere with required refuge space or maintenance clearances.

2.12 DOOR AND ENTRANCE EQUIPMENT

- A. All fastenings of the entrance equipment shall be made secured.

- B. All landing sills are to be retained.
- C. Each door panel is to be provided with two (2) new door guides. These new guides are to be UL labeled and designed to be replaced without removing the door panels. Door guide assembly shall be SEES Enforcer or approved equal.
- D. Existing fascia, dust covers, hangar covers, and toe guards are to be retained unless required by code to be replaced. All equipment is to be cleaned and inspected. If required, provide reinforcement as necessary or replace those components as deemed necessary. Any components that are missing are to be provided with new. All equipment is then required to be painted. Four (4) inch high numerals designating the appropriate floor shall be stenciled on the hoistway enclosure or hoistway doors.
 - 1. All surfaces that are to be provided in a painted enamel finish are first to be cleaned of all dirt, grease and oil and then provided with one (1) coat of rust inhibited mineral paint. A filler primer coat is then to be applied. Final painted enamel finish is to be achieved with two (2) applied enamel coats.
- E. New door stops, and rubber bumpers shall be mounted to the top and bottom of each strut angle in order to cushion and limit the extreme travel of the door panels.
- F. Provide jamb markings on the sides of each entrance frame and mounted sixty (60) inches from the finish floor if required. Each marking shall be a minimum of two (2) inch high numerals with Braille.
- G. Car doors, tracks, and wiring to be completely removed and replaced with new and incorporating existing closed loop door operators.
- H. The existing hoistway door tracks and hangers are to be replaced with new. Door closers are to be replaced with new reel type closers to ensure proper operation of the doors.
- I. New electro-mechanical interlocks with appropriate wiring shall be provided at all hoistway entrances. Hoistway access key-switches are to be provided at top and bottom landings per code and located in the door jambs or in a separate box located adjacent to the entrance frame.
- J. The car and hoistway doors shall be designed in such a way that the doors cannot be opened more than four (4) inches from within the car when the car is outside the unlocking zone in accordance with ASME/ANSI A.17.1.
- K. Hoistway doors: Retain.
- L. Entrance Frames: Retain.

2.13 CAR EQUIPMENT

- A. Car Frame: Retain existing. All components are to be checked, aligned and properly secured necessary.
- B. Passenger Platforms: Retain existing.
- C. Hangers and Tracks: Replace with new.
- D. Car Doors: Replace with new Stainless Steel #4 doors.
- E. Car Sill: Replace with new, match existing.
- F. Floor covering: To be determined. Installed by Elevator Contractor.
- G. Car/Hoistway Door Equipment: All car and hoistway door operating equipment, door tracks, wiring and related door operating equipment shall be furnished incorporating the existing closed loop operator. Existing Car Door Operators are to be Retained.
- H. Door Operator: Retain.
 - 1. Opening speed shall not be less than 3 fps.
 - 2. Hoistway doors shall be automatically closed by an auxiliary closing device if car leaves the landing zone.
 - 3. Differential door timing feature: Provide adjustable timers to vary the time that the doors remain open in response to a car or hall call. The doors shall remain open for one second in response to a car call and five to eight seconds for a hall call. This time shall be reduced to 2 second if the light ray is interrupted. The doors shall remain open as long as passengers are crossing the threshold.
 - 4. Nudging: When doors are prevented from closing for 20 seconds due to failure of the light ray or obstruction, the doors shall close at reduced speed and a buzzer shall sound.
- I. Door Edge Protection: Provide a new Panachrome 3D light curtain door reversal device as manufactured by Janus Elevator Products. The Door Reopening Device shall cause both the car and hoistway doors to reverse, should they detect an obstruction in the elevator. The device electrical wiring shall be supplied with quick disconnects terminals to facilitate replacement. The infrared curtain detector shall include the following:
 - 1. A protective infrared detector field delivered as 154 beam light curtain and shall provide a minimum coverage of 1" above the car sill to a height of 70.9".
 - 2. A fail-safe control system to prevent the doors from closing in case of power loss to the detector.

3. A one-piece full door height protective lens cover designed to have a high resistance to water and dust.
 4. Light curtain shall illuminate green as the doors are opening, flash red as they start to close and stay red as the doors are moving together.
- J. Car Door Contacts: Electrical contacts shall prevent the operation of the elevator by normal operating devices unless car doors are closed or within tolerances allowed by Code.
- K. Door Clutch: Retain.
- L. Restricted Opening Device: Restrict opening of car door(s) to a maximum of four (4) inches outside unlocking zone.
- M. Provide top of car safety railings if required to meet code.
- N. Cab Interior:
1. Wall Panels, Returns and Transoms: Included in \$25,000 Cab Interior Allowance
 2. Down Light Ceiling: provide down light island type ceiling faced in satin stainless steel 1/8" shadow lines set into the surface and furnished with six (6) LED lights with dimmer. (Included in Base Price)
 3. Handrail: New To be determined. (Included in Allowance)
 4. Flooring: Car flooring to be determined by Owner and installed by Elevator Contractor. (Included in Base Price)
- O. Appurtenances:
1. Exhaust Fan: Provide new three – speed exhaust fan, mounted on the car top confirming to the requirements of the Code.

2.14 SIGNALS AND FIXTURES

- A. Provide new signal and operating fixtures as manufactured by Innovations Industries – Premier Series, Oval surround Braille.
- B. All fixtures are to incorporate vandal resistant fasteners.
- C. Car Operating Panel: Provide full swing type main car operating panel in return panel. Panels shall have illuminating buttons. Push-buttons numbered to conform to floors served. Buttons shall be ultra-bright LED illumination in yellow, white, red, green or blue as selected to show registration and extinguish when car stops in response to a call. Buttons shall be raised 1/8 inch above the faceplate Panel shall include an alarm bell button, DOOR OPEN and DOOR CLOSE button. All operating controls shall be located no higher than 54" above the car floor and 35" for alarm button. Provide Phase II emergency fire service switch and components behind a locked cabinet door

clearly marked “Firefighters Operation” engraved and filled on the cabinet door. Fixtures drawings are to be submitted for approval prior to fabrication. Finish to match existing. Full Swing Panels shall maintain a minimum of 3/8” clearance from finish floor. Include the following controls in lockable service cabinet with function and operating positions identified by signage:

1. Hoistway Access switch.
2. Light switch.
3. 3-speed exhaust fan switch.
4. Independent service switch.
5. Constant pressure test button for battery pack emergency lighting.
6. 120-volt, AC, GFCI protected electrical convenience outlet.
7. Braille/Arabic designations shall be die cast and flush with inconspicuous mechanical mounting.
 - a. The plaques shall have numerals and background in a finish selected by the Owner/Consultant.
8. All devices are to match existing finishes.
9. Engrave the car operating panels with the following:
 - a. No Smoking. 1/2 inch high lettering.
 - b. In Case of Fire Do Not Use Elevator. 1/2 inch high lettering.
 - c. Elevator Number: 1 inch high lettering.
 - d. Elevator Capacity: 1/2 inch high lettering.
 - e. Certificate on file with City of Tempe Facilities. 1/2 inch high lettering.

D. Car Position Indicator: Provide in each COP digital type with 3-inch high (minimum) indications within each operating panel. Fixture is to incorporate direction arrows and audible floor passing signal.

A. Hall Buttons: Provide tamper resistant fasteners for all hall pushbuttons. Station shall include flush mounted faceplate. The centerline of the hall call buttons shall be at 3'-6" above the finished floor for compliance with accessibility standards. Buttons shall be raised 1/8 inch above the faceplate. Provide code required Firemen's Service key switch and operational instructions engraved on the faceplate, at the main lobby. Faceplate finish shall match existing. Existing architectural trim to be removed, faceplates to be incorporated to cover existing hole. Finishes to be approved by Owner/Consultant.

B. Digital Hall Lanterns: Provide new manufactured by Innovations Industries. Station shall include flush mounted faceplate. Existing architectural trim to be removed, faceplates to be incorporated to cover existing hole. Finishes to be approved by Owner/Consultant.

C. Hoistway Access Key Switch: A keyed switch shall be provided at the top and bottom landing for hoistway access purposes. Access switch shall be in a

separate fixture with stainless steel faceplate and located adjacent to the entrance frame on the unlocking side.

2.15 COMMUNICATION SYSTEM

- A. Telephone System: Provide new automatic dial hands-free telephone incorporated in the Car Operating Panel compliant with ADA standards.
 - 1. Provide engraved emergency instructions adjacent to the activation button.
 - 2. Instructions in Braille shall be provided below the engraved instructions.
 - 3. Provide a visual indication that consists of a jewel that illuminates once the master station has received a call. Instructions under the visual indicator or within the lighted jewel shall read: "WHEN FLASHING HELP IS ON THE WAY".
- B. Provide wiring from car to telephone terminal box in elevator machine room.
- C. Provide two-way communication between car and machine room if required.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. The contractor shall examine the supporting structure and the conditions under which the work shall be installed and notify the Owner of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the installation until unsatisfactory conditions have been corrected and are acceptable.
- B. Verify dimensions of supporting structure at the site by accurate field measurements. The work shall be accurately fabricated and fitted to the structure. Contractor shall satisfy himself by review of the working drawings and field observation that the clearances and the alignments are proper for the installation of this work.
- C. Coordinate work with the work of other trades and provide items to be placed during the installation at the proper time to avoid delays in the overall work. Use contractor's benchmarks where necessary. Address any possible impacts on the installation schedule.
- D. The elevator contractor shall review the existing electrical system and verify all conditions for proper installation of this work. Verify the size of all feeders and related equipment and furnish all equipment for proper operation. The contractor shall be responsible for furnishing any electrical changes or upgrades required.

3.02 FIELD QUALITY CONTROL

- A. Tests:
1. Perform Pre-Inspection Tests with Consultant prior to inspection by the AHJ (Authority Having Jurisdiction) Inspector.
 2. Perform as required by Code and as required by authorities having jurisdiction.
 3. Provide labor, materials, equipment and connections.
 4. All test results shall be documented and submitted for approval.
 5. Repair or replace defective work as required.
 6. Safety device failure or defective equipment shall be identified, with description of cause and corrective action taken.
 7. Failures for any reasons shall be identified with cause(s) and corrective action taken.
 8. Contractor is responsible for damages due to improper testing.
- B. Final Inspection: When all work is completed, and tested to the satisfaction of the contractor, the contractor shall notify the Owner in writing that the elevators are ready for final inspection and acceptance test. A pre-inspection test shall be coordinated with the Owner and the Consultant prior to the inspection by the AHJ Inspector. A testing and inspection date shall be arranged with the appropriate governing authority. The proper operation of every part of the elevator system and compliance with contract requirements, including compliance with all applicable requirements of the Code, shall be demonstrated to the Owner and the Consultant. Furnish all test instruments, weights, and materials, required at the time of final inspection. The following tests shall be made on the elevator at the time of final inspection:
1. Speed Load Tests: The actual speed of the elevator car shall be determined in both directions of travel with full contract load and with no load in the elevator car. Speed shall be determined by a tachometer. The actual measured speed of elevator car with full load shall be within 5% of rated speed. The maximum difference in actual measured speeds obtained under the various conditions outlined between the "UP" and the "DOWN" directions shall be checked.
 2. Car Leveling Tests: Elevator car leveling devices shall be tested for accuracy of landing at all floors with no load in car, balanced load in car, and with a full load in car, in both directions of travel. Accuracy of floor landing plus or minus $\frac{1}{4}$ " inch shall be determined both before and after the full-load run test.
 3. Vibration/Ride Quality Analysis test conducted in the presence of the Designated Representative to meet ISO Standards.
- C. Final Systems Tests for Smoke Detection/Elevator Recall: After work is completed, conduct a final test of entire system.

- D. Re-inspection: If any equipment is found to be damaged or defective, or if the performance of the elevator does not conform to the requirements of the contract specifications or the Safety Code, no approval or acceptance of the elevator shall be issued until all defects have been corrected. When the repairs and adjustments have been completed and the discrepancies corrected, the Owner shall be notified, and the elevator will be re-inspected. The rejected elevator may be used prior to re-inspection and approval so as to not further burden the occupants of the building. All costs associated with re-inspection are the responsibility of the Contractor. If additional reviews are required due to Provider's gross non-compliance with initial deficiency report, consultant shall bill Provider, and Provider acknowledges it will pay, for additional compliance reviews.
- E. The elevator hoistway, pit and equipment room shall be thoroughly cleaned and painted. All elevator equipment located with the hoistway and machine room, along with machine room floor, pit floor up floor level of first opening, and all pit equipment shall be painted with two coats of deck enamel after all adjusting is completed. Dielectric matting around the elevator controller shall be provided.

3.03 INSTRUCTIONS AND DEMONSTRATION TO OWNER

- A. Contractor shall provide one (1) hours per elevator of onsite demonstration and instructions to the Owner and existing service personnel upon completion of the elevator modernization. Instructions are to include safety procedures, proper operation of all equipment, and routine maintenance procedures. All instructions shall be a training manual and demonstrations are to be videotaped and remain the property of the Owner.

3.04 ADJUSTING AND CLEANING

- A. All equipment shall be adjusted prior to final testing and acceptance.
- B. Restore all exposed equipment soiled or damaged during installation to its original finish. Repair to match adjoining work prior to final acceptance.
- C. Erect all items square, plumb, straight and accurately fitted with tight joints and intersections.
- D. Painting: The following equipment shall be clearly identified by number using four-inch stenciled numerals: crosshead, pit equipment, stop switches, and all machine room and secondary equipment (including but not limited to machines, controllers, drives, transformers, mainline and auxiliary disconnects, etc.). The pit area shall be completely cleaned and painted from the pit floor up to the floor level of the first opening. This shall include the floor, walls, and all pit elevator equipment including the rails. The top of the



elevator shall be completely cleaned and painted. Painting shall include the top of the cab, stiles, crosshead, and all other top of car related equipment. The machine room shall be completely cleaned and painted. Painting shall include the floors, walls, tanks, machine, pipes, gutters. Color to be selected by Owner.

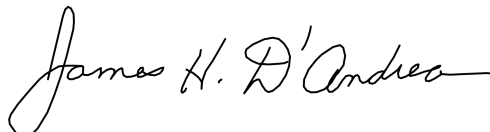
END OF SECTION

DIVISION 23

HEATING, VENTILATING & AIR CONDITIONING

- 23 05 00 Common Work Results for HVAC**
- 23 05 00 General Provisions
 - 23 05 01 Demonstration & Training for HVAC Systems & Components
 - 23 05 13 Common Motor Requirements for HVAC Equipment
 - 23 05 17 Sleeves & Sleeve Seals for HVAC Piping
 - 23 05 18 Escutcheons for HVAC Piping
 - 23 05 20 Electrical & Control Wiring for Mechanical Systems
 - 23 05 29 Hangers & Supports for HVAC Piping & Equipment
 - 23 05 48.13 Vibration Controls for HVAC Piping & Equipment
 - 23 05 53 Identification for HVAC Piping & Equipment
 - 23 05 93 Testing, Adjusting & Balancing for HVAC
- 23 07 00 HVAC Insulation**
- 23 07 13 Duct Insulation
 - 23 07 19 HVAC Piping Insulation
- 23 21 00 Hydronic Piping & Pumps**
- 23 21 15 HVAC Drain Piping
- 23 23 00 Refrigerant Piping**
- 23 23 00 Refrigerant Piping
- 23 31 00 HVAC Ducts & Casings**
- 23 31 13 Metal Ducts
- 23 33 00 Air Duct Accessories**
- 23 33 00 Air Duct Accessories
- 23 81 00 Decentralized Unitary HVAC Equipment**
- 23 81 26 Split-System Air Conditioners

END OF INDEX



James H. D'Andrea



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SECTION 23 05 00

GENERAL PROVISIONS

PART 1 GENERAL

1.01 SCOPE

- A. Provisions of this section apply to all work specified in all sections under Division 23.
- B. In addition, work in Division 23 is governed by the provisions of the Bidding Requirements, Contract Forms, General Conditions, and all sections in Division 01 specifications.
- C. The Contract Documents do not specify exact installation means and methods or Contractor safety procedures. Installation means and methods and safety procedures are the responsibility of the Contractor. No instruction or statement made on the Contract Documents shall be interpreted to shift this responsibility away from the Contractor.
- D. These specifications contain statements which are more definitive or more restrictive than those contained in the General Conditions. Where these statements occur, they shall take precedence over the General Conditions.

1.02 DEFINITIONS

- A. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unconditioned shelters.
- B. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings, in duct shafts, and in utility chases.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations and mechanical yards.
- D. Exposed, Interior Installations: Exposed to view indoors. Examples include finished spaces and mechanical equipment rooms.
- E. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unconditioned spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and utility tunnels.

1.03 EXAMINATION OF PREMISES

- A. Visit the site, verify all measurements and project conditions, and pay all costs necessary to perform the work.

1.04 MECHANICAL CONTRACTOR

- A. The Mechanical Contractor shall hold a current contracting license that has been valid for a minimum of 2 years in the State of Arizona as a mechanical contractor.

1.05 REGULATIONS, PERMITS, FEES, CHARGES, INSPECTIONS

- A. Regulations: Comply with all applicable codes, rules and regulations.
- B. Fees and Permits: Pay all connection, installation, use, disposal, development, etc., fees and/or charges. Obtain and pay for all required permits and licenses. Refer to Division 01 specifications.
- C. Inspections: All work must be inspected and approved by the local authorities. Prior to final approval, furnish the Engineer with certificates of inspections and approvals by the local authorities in accordance with Division 01 specifications.

1.06 DRAWINGS AND SPECIFICATIONS

- A. Refer to Division 01 specifications for additional information on submittals and shop drawings.
- B. If a conflict exists on the drawings or between the drawings and specifications, promptly notify the Engineer.

1.07 SUBMITTALS

- A. Submittals are for information and coordination only. The Engineer will diligently review the submittals and attempt to verify compliance with the project requirements. Such review, however, does not constitute approval or disapproval of obligation to comply with all project requirements. The submittals are not to be construed to be contract documents. Any failure by the Engineer to note a point of non-compliance shall not be construed to be acceptance or approval of the discrepancy.
- B. Product Information Sheets: Provide project-specific manufacturer's literature which includes the information required by the Product Data paragraph of the applicable specification section. Where Product Information Sheets show multiple models or options, clearly mark the model and options to be provided.

- C. Assembly: Assemble all required submittal information for each specification section and submit in Portable Document Format (PDF).
 - 1. Assemble PDF submittals in one PDF file for each division. Separate and order sections within each file by corresponding specification number. Provide bookmarks at the first page of each section and label each bookmark with the specification number and name to allow for easy navigation of the submittal.
 - 2. Partial submittals and submittals that are not project specific will be returned without review. Submittals for Building Automation System may be submitted separately.
- D. Identification and Information:
 - 1. Name the PDF file with the project name, division number and sequential submittal number (i.e., the first submittal shall be No. 1; the second submittal shall be No. 2).
 - 2. Provide a cover sheet at the front of each submittal with the following information:
 - a. Project name.
 - b. Date.
 - c. Name of Engineer.
 - d. Name of Contractor.
 - e. Name of subcontractor.
 - 3. Provide a cover sheet at the front of each submittal section with the following information:
 - a. Name of supplier.
 - b. Name of manufacturer.
 - c. Number and title of appropriate specification section.
 - d. Drawing number and detail references, as appropriate.
 - e. Other necessary identification.
- E. Options:
 - 1. Identify options requiring selection by the Engineer.
 - 2. Identify options included with submittal item.
- F. Deviations: Identify deviations from the Contract Documents on submittals.
- G. Furnished by Others: This project is to provide a complete and functional system. Where material or labor is indicated in the submittal to be provided “by others” clearly indicated who is providing those items and include information to indicate proper coordination.

1.08 MATERIAL SAFETY DATA SHEETS

- A. Provide current, Material Safety Data Sheets (MSDS), for all hazardous materials that are proposed for use at the project site.

1. Provide one complete set to the Owner for review and approval a minimum of 1 week prior to the delivery of any hazardous materials to the site.
2. Maintain a second complete set at the project location, readily accessible by both the Owner's personnel and the Contractor's personnel.

1.09 REQUEST FOR INFORMATION

- A. Request for Information (RFI):
 1. A document submitted by the Contractor requesting clarification of a portion of the Contract Documents, hereinafter referred to as RFI.
 2. A properly prepared request for information shall include a detailed written statement of the clarification, apparent conflict, or information requested that indicates the specific drawings or specification in need of clarification and the nature of the clarification requested.
 - a. Drawings shall be identified by drawing number and location on the drawing sheet.
 - b. Specifications shall be identified by section number, page, and paragraph.
 3. Include a proposed solution, where appropriate, based upon the field conditions and best knowledge of the Contractor.
- B. Improper or Frivolous RFIs: RFIs which are not properly prepared or that request information which is clearly shown in the Contract Documents will be returned unanswered. Processing time for multiple submissions of improper or frivolous RFIs will be billed at the Engineer's standard hourly rate to the Owner who may deduct an equal amount from the monies due the Contractor.

1.10 AS-BUILT DRAWINGS

- A. As-Built Drawings: Maintain one set of marked-up paper copies of the Contract Drawings.
 1. Preparation: Mark As-Built Drawings to show the actual installation where installation varies from that shown originally. Include all equipment, and underground and overhead piping.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Include dimensions both horizontally and vertically to permanent points of reference accurate within 6 inches. Include descriptors such as "below slab," "above ceiling," etc.
 - c. Record data daily or as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
 2. Mark the As-Built Drawings completely and accurately. Utilize personnel proficient at recording graphic information in production of As-Built Drawings.

3. Mark As-Built Drawings with erasable, red colored pencil. Use other colors to distinguish between changes for different categories of the work at the same location.
 4. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Format: Identify and date each As-Built Drawing; include the designation “PROJECT AS-BUILT DRAWING” in a prominent location.
1. Organize newly prepared As-Built Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 2. Identification, as follows:
 - a. Project name.
 - b. Date.
 - c. Designation “PROJECT AS-BUILT DRAWINGS.”
 - d. Name of Engineer.
 - e. Name of Contractor.
 3. Remove or obscure Engineer’s seal from As-Built Drawings.

1.11 OPERATION AND MAINTENANCE MANUAL

- A. Prior to completion of the project, compile a complete Equipment, Operation and Maintenance Manual for all equipment supplied under Division 23.
- B. Schedule:
1. Submit a preliminary copy of the manual not less than 30 days prior to Substantial Completion for review and comment.
 2. Submit the final version of the manual not more than 4 weeks after Substantial Completion of the project.
- C. Format: Submit manuals in both of the following formats:
1. PDF Electronic Files: Assemble each manual into a single master directory with sub-directories for the individual PDF files for each system and piece of equipment. Provide a table of contents file with hyperlinks to each of the individual PDF files within the sub-directories. Submit on digital media acceptable to the Engineer.
 - a. Name each directory, sub-directory, and document file with applicable item name.
 - b. Enable reviewer comments on draft submittals.
 2. Paper Copies: Assemble paper copies in 3-ring binders. Separate and order systems and equipment within each binder. Provide labeled tabs at each section with a table of contents at the front of the binder. The table of contents shall indicate the tab number and the information contained at that tab. Enclose title pages and directories in clear plastic sleeves.

- D. Provide Operation and Maintenance Manuals for all systems, subsystems, and equipment that require operation and regular maintenance, or have replaceable parts.
- E. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, product data, manufacturer's maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below. In addition to requirements in this section, include operation and maintenance data required in individual specification sections.
- F. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of installer or supplier and maintenance service agent, and cross-reference specification section number and title in Project Manual.
- G. Product Data: Include the following information:
 - 1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
 - 2. Approved submittals.
 - 3. Include the following if not shown on approved submittals:
 - a. Product name and model number. Use designations for products indicated on Contract Documents.
 - b. Manufacturer's name.
 - c. Equipment identification with serial number of each component.
 - d. Equipment function.
 - e. Operating characteristics.
 - f. Limiting conditions.
 - g. Performance curves.
 - h. Engineering data and tests.
- H. Operating Procedures: Include the following, as applicable:
 - 1. Startup procedures.
 - 2. Equipment or system break-in procedures.
 - 3. Routine and normal operating instructions.
 - 4. Regulation and control procedures.
 - 5. Instructions on stopping.
 - 6. Normal shutdown instructions.
 - 7. Seasonal and weekend operating instructions.
 - 8. Required sequences for electric or electronic systems.
 - 9. Special operating instructions and procedures. Including precautions against improper use.
 - 10. Operating logs.

- I. Wiring Diagrams: Diagram of factory-installed wiring including any options as well as any field modifications.
- J. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
- K. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification. Include valve locations and designations.
- L. Manufacturer's Maintenance Documentation: Manufacturer's maintenance documentation including the following information for each component part or piece of equipment:
 - 1. Standard maintenance instructions and bulletins.
 - 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 - 3. Identification and nomenclature of parts and components.
 - 4. List of items recommended to be stocked as spare parts.
- M. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
 - 1. Test and inspection instructions.
 - 2. Troubleshooting guide.
 - 3. Precautions against improper maintenance.
 - 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - 5. Aligning, adjusting, and checking instructions.
 - 6. Demonstration and training video recording, if available.
- N. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
- O. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturer's maintenance documentation and local sources of maintenance materials and related services.
- P. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- Q. Licenses: Include copies of any licenses with requirements including inspection and renewal dates.
- R. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

- S. Test and Balance Report: Include a final approved copy of the Test and Balance Report.

1.12 WORK AND MATERIALS

- A. Unless otherwise specified, all materials must be new and of the quality specified. The workmanship shall be of a quality that is acceptable to the Engineer and Owner, and is equal to the standards of the trades. The Contractor must staff the project with sufficient skilled workmen, including a fully qualified construction superintendent, to complete the work in the time allotted. The superintendent must be qualified to supervise all of the work in his work category.
- B. Uniformity: Unless otherwise specified, provide all equipment and products of the same type or classification by the same manufacturer.

1.13 APPROVALS OF MATERIALS AND EQUIPMENT

- A. Refer to Division 01 specifications for description of material and equipment for prior approvals and substitutions.

1.14 COOPERATIVE WORK

- A. Correct without charge any work requiring alteration due to lack of proper supervision or failure to make proper provision in time. Correct without charge any damage to adjacent work caused by the alteration. Refer to Division 01 specifications for additional requirements.
- B. Cooperative work Includes:
 - 1. General supervision and responsibility for proper location, rough-in and size of work related to Division 23 but provided under other divisions of these specifications.
 - 2. Installation of sleeves, inserts and anchor bolts for work under sections in Division 23.
 - 3. Sealing of penetrations through fire and smoke barriers caused by work installed as part of Division 23.

1.15 EXISTING MATERIALS AND EQUIPMENT

- A. Disposition: With the exception of items that are to be reused or retained by the Owner, all other materials indicated to be removed shall be removed and legally disposed of by the Contractor. Items that are indicated to be retained or returned to the Owner shall be delivered to a storage area designated by the Owner.

- B. **Unused Materials:** All unused piping, ductwork, controls and miscellaneous materials shall be removed by the Contractor except where located within walls, below or above existing construction which is not being altered and would require removal and replacement of this existing construction. All visible piping, ductwork, etc., shall be removed and sealed or capped within wall, below floor, or above ceiling unless noted otherwise.
- C. **Exterior Services:** The Contractor shall be responsible for maintaining mechanical and control service to the existing building during the construction period. Existing services are to be retained until such a time that the new services, if any, are completely installed and ready for use. Scheduling of service interruptions is to be coordinated with the Engineer and Owner.
- D. **Disconnect, demolish, and remove mechanical systems, equipment, and components that are indicated to be removed.**
 - 1. **Piping to be Removed:** Remove portion of piping indicated to be removed and cap or plug remaining piping with the same or compatible piping material. Patch insulation, as required, to match adjacent areas.
 - 2. **Piping to be Abandoned In Place:** Drain piping and cap or plug piping with the same or compatible piping material.
 - 3. **Ducts to be Removed:** Remove portion of ducts indicated to be removed and cap remaining ducts with the same or compatible ductwork material. Patch insulation, as required, to match adjacent areas.
 - 4. **Ducts to be Abandoned In Place:** Cap ducts with the same or compatible ductwork material.
 - 5. **Equipment to be Removed:** Disconnect and cap services and remove equipment.
 - 6. **Equipment to be Removed and Reinstalled:** Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - 7. **Equipment to be Removed and Salvaged:** Disconnect and cap services and remove equipment and deliver to the Owner.
- E. **Continuity of Services in Existing Building:** The Contractor shall permanently reroute existing mechanical and control services or provide temporary connection as required to maintain service to existing equipment and systems in building which are to remain in service.
- F. **Rerouting and Relocation of Existing Mechanical Equipment and Services in Existing Building:**
 - 1. **General:** The Contractor shall reroute, relocate all existing materials which are in conflict with the building alterations and which are required to be maintained in use.
 - 2. **Existing Piping and Ductwork:** Where applicable, existing material may be reused in their original location unless otherwise indicated.

- G. Testing: All existing services affected by the new construction and which are modified, reused or are to remain in operation shall be returned to their original condition. The existing services shall be tested as new, as described in other sections of these specifications. If for any reason these requirements cannot be met, the Contractor shall immediately notify the Engineer.

1.16 CONSTRUCTION FACILITIES

- A. General: Under this division of the specifications, execute all work in a manner to provide safe and lawful ingress and egress to the Owner's establishment and such facilities shall be kept clear of materials or equipment. Refer to Division 01 specifications for additional requirements.
- B. Furnish and maintain from the beginning to the completion of all work all lawful and necessary security, guards, railings, fences, canopies, lights, fire protection, and warning signs. Take all necessary precautions required by city and state laws to avoid injury or damage to any and all persons and property.

1.17 GUARANTEE

- A. Guarantee all material, equipment, installation and workmanship for all sections under Division 23 in writing to be free from defects of material and workmanship for 1 year from date of final acceptance as outlined in Division 01 specifications. Equipment warranties shall be a minimum of 1 year from date of Substantial Completion or as specified elsewhere. Replace without charge any material or equipment proving defective during this period. The guarantee shall include performance of the equipment under all conditions of load, installing any additional items of control and/or protective devices as required and the replacing of any refrigerant lost.

1.18 MECHANICAL WIRING

- A. Provide all temperature control wiring, interlock wiring, and equipment control wiring for the equipment that is to be provided under Division 23 unless wiring is specifically shown on the electrical drawings.
- B. The following schedule is intended to summarize the division of work and material responsibilities between the Mechanical Contractor, Controls Contractor and Electrical Contractor.

Item	Furn. By	Set By	Power Wiring	Control Wiring
Equipment Motors	MC	MC	EC	--
Motor Control Center	EC	EC	EC	CC
Motor Starters, Controllers, Contactors & Overload Heaters	MC*	EC**	EC	CC

Item	Furn. By	Set By	Power Wiring	Control Wiring
Fused & Non-Fused Disconnect Switches	EC**	EC**	EC	--
Manual Operating Switches, Multi-Speed Switches, Pushbutton Stations & Pilot Lights	CC	CC	CC	CC
Control Relays & Transformers	CC	CC	CC	CC
Line Voltage Thermostats & Time Switches***	MC	MC	EC	EC
Low-Voltage Thermostats	MC	MC	-	MC
Temperature Control Panels	MC	MC	EC	CC
Smoke Detectors (Duct Mounted)	EC	MC	EC	MC or CC
Motor & Solenoid Valves, Damper Motors, PE & EP Switches	CC	MC	CC	CC
Water Treatment Equipment	MC	MC	EC	CC
<p>MC = Mechanical Contractor CC = Controls Contractor EC = Electrical Contractor</p> <p>*Except where such devices are located in MCCs.</p> <p>**Unless required by these specifications to be provided as part of a factory-furnished assembly (i.e., fan coils, air handlers, chillers, etc.).</p> <p>***Motor-drive units which are controlled from line voltage automatic controls such as line voltage thermostats, float switches or time switches which conduct full load current of the motor shall be wired for both power and control circuit under the electrical contract.</p>				

PART 2 PRODUCTS

2.01 MACHINERY DRIVES

- A. Unless otherwise specified in Division 23 equipment sections, use V-belts designed for 150% of capacity for all belt drives. For multiple belt drives, use matched sets, so marked at the factory.
- B. On drives with not more than two belts, provide adjustable pitch motor sheaves with the midpoint of the adjustment range equal to that required to achieve the specified fan capacity.
- C. On motors with drives with more than two belts, furnish non-adjustable sheaves, providing the specified fan capacity.

2.02 MACHINERY ACCESSORIES

- A. Guards: Provide totally enclosed OSHA-type belt guards for all rotating equipment. Design guards to be readily removable for access to belt drives.

2.03 GROUT

- A. Description: ASTM C1107, Grade B, non-shrink and non-metallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, non-staining, non-corrosive, non-gaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5,000-psi, 28-day compressive strength.
- B. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.01 SUBMITTALS

- A. Prepare submittals as directed for review by the Contractor, Owner, and Engineer.
- B. Submit one copy of PDF submittals via email, project website or other electronic media.

3.02 REFRIGERANT HANDLING AND DOCUMENTATION

- A. Refrigerant Handling: Handle, contain and dispose of refrigerant in compliance with local, federal, and EPA regulations and requirements.
- B. Documentation: Maintain documentation for all refrigerant brought onto or removed from project location in compliance with local, federal, and EPA regulations and requirements. Submit documentation to the Owner and Engineer.

3.03 AS-BUILT DRAWINGS

- A. Recording: Post changes and modifications to As-Built Drawings as they occur; do not wait until the end of the project.
- B. Maintenance of As-Built Drawings, Submittals, and Shop Drawings: Store record documents in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for the Engineer's reference during normal working

hours. As-Built Drawings will be reviewed by the Owner and Engineer at each pay request review.

- C. Submit As-Built Drawings to the Engineer at completion of project.

3.04 OPERATION AND MAINTENANCE MANUALS

- A. Prepare Operation and Maintenance Manuals as directed.
- B. Submit a preliminary electronic copy of the Operation and Maintenance Manual to the Engineer for review.
- C. Make any corrections noted from the Engineer's review upon receipt of comments and resubmit as required.
- D. Submit the final, corrected Operation and Maintenance Manual in both paper and electronic format to the Engineer.

3.05 VERIFICATION OF DIMENSIONS

- A. Scaled and figured dimensions are approximate only. Before proceeding with work, carefully check and verify dimensions at site, and be responsible for properly fitting equipment and materials together and to the structure in spaces provided.
- B. Drawings are diagrammatic and many offsets, bends, special fittings and exact locations are not indicated. Carefully study drawings and premises in order to determine best sequence and installation methods, exact locations, routes, building obstructions, and install apparatus and equipment in available locations. Install apparatus and equipment in manner and in locations to avoid obstructions, preserve headroom, and keep openings and passageways clear.

3.06 CUTTING AND PATCHING

- A. Cut work and patch per Division 01 specifications as necessary to properly install the new work. As the work progresses, coordinate necessary openings, holes, chases, etc., in their correct location. If the required openings, holes and chases are not in their correct locations, make the necessary corrections at no cost to the Owner. Avoid excessive cutting and do not cut structural members without the consent of the Engineer. Include as a part of the work all structural framing required by penetrations through the roof and necessary design and installation of steel to support equipment, ducts and pipes between structural steel unless shown on the structural drawings.

3.07 CLOSING-IN OF UNFINISHED WORK

- A. Cover no work until inspected, tested and approved. Where work is covered before inspection and test, uncover it, and when inspected, tested and approved, restore all work to original proper condition.

3.08 EXCAVATION AND BACKFILL

- A. Perform all necessary excavation, shoring and backfilling required for the proper laying of all pipes, ducts, and conduits inside the building and premises, and outside as may be necessary. Remove all excess excavated materials from the site or dispose of onsite as directed by the General Contractor.
- B. Excavate all trenches open cut, keep trench banks as nearly vertical as practicable, and sheet and brace trenches where required for stability and safety. Excavate trenches true to line and make bottoms not less than 18 inches wide but no wider than necessary to provide ample work room. Excavate to provide continuous granular bedding as indicated. Do not cut any trench near or under footings without first consulting the Engineer. Comply with OSHA requirements.
- C. Provide not less than 4 inches of granular material as duct or pipe bedding. Grade and compact trench bedding accurately prior to laying duct or pipe in trench to provide uniform bearing and support for each section of pipe along its entire length. Dig “bell” holes after the trench bottom has been graded and compacted. Granular material shall be pea gravel or sand per MAG Standards.
- D. Provide backfilling and compaction in accordance with provisions of these specifications and under the direction of the Engineer to the required density.
- E. Provide not less than 4 inches of granular material, the same as duct or piping bedding, all around duct or pipe. Make the first 2 feet of fill in 6-inch layers, each thoroughly compacted as directed with no puddling, and free from rocks, large clods of earth, leaves, branches, and debris. Compact the rest of the backfill as directed, using in the backfill no rocks larger than 4 inches in diameter, and using no rock in the top 12 inches.

3.09 ACCESSIBILITY

- A. Install valves, dampers, thermometers, gauges, traps, cleanouts, control devices or other specialties requiring reading, adjustment, inspection, repairs, removal or replacement conveniently and accessibly throughout the finished building. Where any of these devices are shown on the Contract Drawings to

be installed above any inaccessible ceiling or behind any inaccessible wall, the Mechanical Contractor shall furnish access doors or panels as required.

- B. All access doors or panels in walls and ceilings required for access to control devices, traps, valves and similar devices are to be furnished and installed as part of the work under this section. Provide type as specified in Division 08 specifications.
- C. Where any duct-mounted access doors or other items requiring access or maintenance are installed above an inaccessible ceiling or behind an inaccessible wall, the Mechanical Contractor shall furnish access doors or panels as required unless noted otherwise. Provide type as specified in Division 08 specifications.
- D. Refer to architectural drawings for type of wall and ceiling in each area and for rated construction.
- E. Coordinate work of various sections to locate valves, traps, and dampers with others to avoid unnecessary duplication of access doors.
- F. The Contractor, along with the Owner's representative, shall complete the Mechanical Accessibility/Clearance Checklist at the end of this section for all mechanical equipment. The chart shall be submitted to the Engineer for approval prior to Substantial Completion. All conflicts shall be resolved to the Engineer's and Owner's satisfaction prior to submission.

3.10 FLASHINGS

- A. Flash and counterflash all piping, conduits and ductwork penetrating roofing membrane with flashing per roofing manufacturer's recommendations. Refer to architectural drawings for detailing of duct and pipe penetrations through roof.
- B. Flash and counterflash all piping, conduits and ductwork penetrating exterior walls. Refer to architectural drawings for detailing of duct and pipe penetrations through walls.

3.11 PRODUCT AND EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. All equipment, valves, sensors, dampers, detectors, etc., shall be installed in strict conformance with the manufacturer's recommendations and all codes.
- B. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.

- C. Install equipment, ductwork, and piping level and plumb, parallel and perpendicular to other building systems and components, unless otherwise indicated.
- D. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- E. Install equipment, ductwork, and piping to allow right-of-way for piping installed at required slope.
- F. Do not install any equipment in an application not recommended by the manufacturer.

3.12 EQUIPMENT ROUGH-IN

- A. Rough in all equipment and fixtures as designated on the approved submittals and in the Construction Documents. The Contract Drawings indicate only the approximate location of rough-ins. The exact rough-in locations must be determined from large-scale certified drawings. The Contractor shall obtain all certified rough-in information before progressing with any work for rough-in.
- B. Be responsible for providing all outlets and services of proper size at the required locations.
- C. Minor changes in the Contract Drawings shall be anticipated and provided for under this Contract.
 - 1. Rough-in only (unless otherwise designated on the drawings) shall include providing all services as indicated and required, including all ductwork, piping, valves, and fittings. Valve and cap all piping stub-outs. Cap all ductwork stub-outs in a manner suitable for future extension.

3.13 OWNER-FURNISHED AND OTHER EQUIPMENT

- A. Rough-in only for all Owner-furnished equipment (refer to Division 01 specifications) and all equipment furnished under other sections of the specifications, except as otherwise specified and/or noted on the drawings.
- B. Obtain rough-in drawings from the Owner or other contractors prior to roughing-in any services.
- C. Provide all services required. Valve and cap all piping, cap all ductwork, and leave in a clean and orderly manner.

3.14 EQUIPMENT FINAL CONNECTIONS

- A. Provide all piping and duct final connections for all equipment under Division 23 and as indicated on the drawings.

3.15 MACHINERY DRIVES

- A. After tests have been performed on the air-conditioning and air-handling systems, make without cost, not more than one change in the size of non-adjustable sheaves to obtain the required air quantities as direct by the Test and Balance Contractor.

3.16 EQUIPMENT SUPPORTS

- A. Erection of Metal Supports and Anchorages:
 - 1. Refer to Division 05 specifications for structural steel.
 - 2. Design, cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment. Neatly fabricate and erect steel work with burrs and welding spatter ground off. Paint after fabrication with a rust-inhibitive primer.
 - 3. Field Welding: Comply with AWS D1.1.
- B. Erection of Wood Supports and Anchorages:
 - 1. Design, cut, fit, and place wood grounds, nailers, blocking, and anchorages to support and anchor mechanical materials and equipment.
 - 2. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
 - 3. Attach to substrates as required to support applied loads.
- C. Where supports, foundations, stands, suspended platforms for machinery, tanks, or other equipment are indicated or specified, perform the following:
 - 1. Locate support members to avoid equipment strainers and interference with piping connections, tube pulling or other maintenance operations.
 - 2. Where saddles are required, use cast-iron or welded-steel saddles with curvature to fit the tank shell.
 - 3. Mount power-driven equipment on common base with driver.
- D. Concrete Inserts: Furnish and install all concrete inserts required for all materials and equipment specified and/or shown on the drawings for Division 23.
- E. Concrete Housekeeping Pads and Isolation Bases: Work under this section includes coordination of construction of all concrete foundations indicated or required for equipment specified under Division 23. Materials and

workmanship shall be described in Division 03 specifications. Anchor equipment to concrete housekeeping pads and isolation bases according to equipment manufacturer's written instructions and according to seismic codes at project.

1. Construct concrete housekeeping pads and isolation bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete pads to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the pad.
3. Install epoxy-coated anchor bolts for supported equipment that extends through concrete pads, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

F. Grouting:

1. Grout under all equipment after leveling, filling completely the space between machinery bed plate and foundation surface as specified in Division 03 specifications.
2. Mix and install grout for mechanical equipment base bearing surfaces, pumps and other equipment base plates, and anchors.
3. Clean surfaces that will come into contact with grout.
4. Provide forms as required for placement of grout.
5. Avoid air entrapment during placement of grout.
6. Place grout, completely filling equipment bases.
7. Place grout on concrete pads and isolation bases and provide smooth bearing surface for equipment.
8. Place grout around anchors.
9. Cure placed grout.
10. Finish exposed surface of grout for a neat appearance.

3.17 CLEANUP

- A. In addition to cleanup specified in Division 01 specifications, thoroughly clean all parts of the equipment. Where exposed parts are to be painted, thoroughly clean off any splattered construction materials and remove all oil and grease spots. Wipe the surface carefully and scrape out all cracks and corners.
- B. During the progress of the work, keep the premises clean and free of debris.

3.18 PAINTING

- A. Except as otherwise specified or indicated in the architectural drawings and/or specifications, paint all exposed unfinished metal pipe, duct, hangers, supports, rods, hardware, and equipment with one coat of rust-inhibiting primer. Galvanized, stainless-steel, or aluminum ductwork, pipe, supports, hangers, rods and hardware, and factory-painted equipment shall be considered as having primed surface.
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.
- C. Finished painting is specified in Division 09 specifications.

3.19 FIRESTOPPING

- A. Coordinate with the firestopping installer for sealing of all penetrations of fire and smoke barriers and other rated assemblies created during the installation of the Division 23 work.

3.20 OBJECTIONABLE NOISE AND VIBRATION

- A. Design, construct and brace the metal partitions, ducts and sheet metal housings to prevent vibration or rattling when systems are in operation. Install connections to equipment so noise and vibration will not reach the conditioned area through ducts, piping, conduit, sheet metal work, or the building structure.

3.21 WELDING

- A. Procedures:
 - 1. All procedures and welders must be qualified in accordance with the requirements of Section IX, ASME Boiler and Pressure Vessel Code and ANSI code for power piping B31.1. Procedure qualification test records and acceptance shall be submitted with the welding procedure prior to the start of fabrication.
 - 2. The Engineer's inspector or authorized representative will review performance qualification records of individual welders.

END OF SECTION

Edition -----1219

SECTION 23 05 01

DEMONSTRATION & TRAINING FOR HVAC SYSTEMS & COMPONENTS

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes administrative and procedural requirements for demonstration of proper operation of equipment and instructing the Owner's personnel, including the following:
 - 1. Demonstration of operation of systems, subsystems, and equipment.
 - 2. Training in operation and maintenance of systems, subsystems, and equipment.

1.02 CLOSEOUT SUBMITTALS

- A. At completion of training, submit complete training manual(s) for the Owner's use.

1.03 QUALITY ASSURANCE

- A. Instructor Qualifications: A factory-authorized service representative experienced in operation and maintenance procedures and training.

1.04 COORDINATION

- A. Complete demonstrations prior to Substantial Completion.
- B. Complete instruction prior to Final Completion.
- C. Coordinate demonstration and instruction schedule with the Owner's operations. Adjust schedule as required to minimize disrupting the Owner's operations.
- D. Coordinate content of training modules with content of approved Operation & Maintenance Manuals.

PART 2 PRODUCTS

2.01 INSTRUCTION PROGRAM

- A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system. Include training for all HVAC systems and equipment such as heat pumps, air-conditioners, heating and ventilating units, evaporative coolers, make-up air

units, chillers, cooling towers, pumps, fans, air handlers, etc., and as required by individual specification sections.

- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
 - a. System, subsystem, and equipment descriptions.
 - b. Operating standards.
 - c. Regulatory requirements.
 - d. Equipment function.
 - e. Operating characteristics.
 - f. Limiting conditions.
 - g. Performance curves.
 2. Documentation: Review the following items in detail:
 - a. Emergency manuals.
 - b. Operation & maintenance manuals.
 - c. Project record documents.
 - d. Identification systems.
 - e. Warranties and bonds.
 - f. Maintenance service agreements and similar continuing commitments.
 3. Emergencies: Include the following, as applicable:
 - a. Instructions on meaning of warnings, trouble indications, and error messages.
 - b. Instructions on stopping.
 - c. Shutdown instructions for each type of emergency.
 - d. Operating instructions for conditions outside of normal operating limits.
 - e. Sequences for electric or electronic systems.
 - f. Special operating instructions and procedures.
 4. Operations: Include the following, as applicable:
 - a. Startup procedures.
 - b. Equipment or system break-in procedures.
 - c. Routine and normal operating instructions.
 - d. Regulation and control procedures.
 - e. Control sequences.
 - f. Safety procedures.
 - g. Instructions on stopping.
 - h. Normal shutdown instructions.
 - i. Operating procedures for emergencies.
 - j. Operating procedures for system, subsystem, or equipment failure.
 - k. Seasonal and weekend operating instructions.
 - l. Required sequences for electric or electronic systems.
 - m. Special operating instructions and procedures.

5. Adjustments: Include the following:
 - a. Alignments.
 - b. Checking adjustments.
 - c. Noise and vibration adjustments.
 - d. Economy and efficiency adjustments.
6. Troubleshooting: Include the following:
 - a. Diagnostic instructions.
 - b. Test and inspection procedures.
7. Maintenance: Include the following:
 - a. Inspection procedures.
 - b. Types of cleaning agents to be used and methods of cleaning.
 - c. List of cleaning agents and methods of cleaning detrimental to product.
 - d. Procedures for routine cleaning.
 - e. Procedures for preventive maintenance.
 - f. Procedures for routine maintenance including the following:
 - 1) Lubrication.
 - 2) Filter replacement.
 - 3) Belt tensioning.
 - 4) Belt replacement.
 - g. Instruction on use of special tools.
8. Repairs: Include the following:
 - a. Diagnosis instructions.
 - b. Repair instructions.
 - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - d. Instructions for identifying parts and components.
 - e. Review of spare parts, including lubricants, filters, and belts needed for operation and maintenance.

PART 3 EXECUTION

3.01 PREPARATION

- A. Inspect and test each system, subsystem and piece of equipment prior to demonstration. Confirm proper operation prior to scheduling demonstrations.
 1. Replace defective work or material.
 2. Repeat inspection and testing until defects are eliminated.
- B. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements for operation and maintenance data.

3.02 DEMONSTRATION

- A. Inspect and operate satisfactorily, in the presence of the Engineer and Owner, each system and item of equipment, including accessories.

3.03 INSTRUCTION

- A. Engage qualified instructors to instruct the Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 - 1. The Owner will furnish the Contractor with names and positions of participants.
- B. Scheduling: Provide instruction at mutually agreed-upon times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
 - 1. Schedule training with the Owner with an advance notice of at least 7 days.
- C. Evaluation: At the conclusion of each training module, assess and document each participant's mastery of the module by use of an oral or demonstration performance-based test.

END OF SECTION

Edition 0208-1015

SECTION 23 05 13

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes general requirements for single-phase and polyphase, general-purpose, horizontal and vertical, small and medium, squirrel-cage induction motors for use on AC power systems up to 600 volts and installed at equipment manufacturer's factory or shipped separately by the equipment manufacturer for field installation.

1.02 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.
 - 5. Variable frequency and variable speed drives.

PART 2 PRODUCTS

2.01 GENERAL MOTOR REQUIREMENTS

- A. Comply with requirements in this section except when stricter requirements are specified in HVAC equipment schedules or sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.
- C. Motors 3/4 HP and larger, except as otherwise noted, shall be designed for 3 phase, 60 Hz power supply.
- D. Motors 1/2 HP and smaller, except as otherwise noted, shall be designed for 120 volt, single phase, 60 Hz power supply.
- E. Motors not directly exposed to weather and located in non-hazardous spaces shall be in dripproof enclosures or as indicated on the drawings.
- F. Motors shall be totally enclosed, fan cooled where directly exposed to weather or as indicated on the drawings.

- G. High-starting torque, totally enclosed or explosion-proof motors to be used in all hazardous areas or as indicated on the drawings.

2.02 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 104°F and at an altitude of 3,300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.03 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Premium efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multi-Speed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, anti-friction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating.
- H. Insulation: Class F.
- I. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.04 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multi-Speed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers:
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - 2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
 - 5. Bearing Protection Device: Field- or factory-applied shaft grounding ring consisting of metal ring supporting carbon microfibers to provide grounding path between shaft and motor casing.

2.05 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 HP shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.
 - 5. Electronically commutated.
- B. Multi-Speed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, anti-friction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Insulation: Class F where motors are installed on roofs outside the airstream.
- E. Motors 1/20 HP and Smaller: Shaded-pole type.
- F. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.06 ELECTRONICALLY COMMUTATED MOTOR

- A. Description: Motor with integral electronics to convert incoming AC power to DC power to drive motor shaft along with controls to vary the speed of the motor based on an internal or external signal.

- B. Controls: Provide with internal controls and programming or external inputs, depending on the application, to allow for motor speed control.
- C. Motor Protection: Provide with integral safeties to limit motor speed or de-energize motor if operating in an over-temperature or overloaded condition.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Arrange and set motors.
- B. Line up motors on direct drive equipment using dial-type gauges.
- C. Connections and testing of motor for proper rotation/phasing shall be under Division 26.

END OF SECTION

Edition 0605-1018

SECTION 23 05 17

SLEEVES & SLEEVE SEALS FOR HVAC PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes:
 - 1. Sleeves.
 - 2. Sleeve-seal systems.
 - 3. Grout.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 PRODUCTS

2.01 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast- or ductile-iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A53/A53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. Galvanized-Steel-Sheet Sleeves: Minimum thickness 0.0239-inch; round tube closed with welded longitudinal joint.

2.02 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advance Products & Systems, Inc.
 - 2. CALPICO, Inc.
 - 3. Link-Seal by GPT, an EnPro Industries Company.
 - 4. The Metraflex Company.
 - 5. Proco Products, Inc.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel or reinforced nylon polymer.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.03 GROUT

- A. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Non-shrink; recommended for interior and exterior applications.
- C. Design Mix: 5,000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.01 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
 1. Sleeves are not required for core-drilled holes through exterior walls or slab-on-grade floors.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and interior of sleeve.
 1. For core-drilled holes, size hole large enough to provide 1-inch annular space between piping and concrete wall or slab-on-grade floor.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 2. Using grout, seal the space outside of sleeves in slabs and walls.
- D. Install sleeves in core-drilled holes in concrete floors in mechanical equipment areas or other wet areas.
 1. Extend sleeves 2 inches above finished floor level.
 2. Using grout, seal the space outside of sleeves.

- E. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 specifications.
- F. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 specifications.

3.02 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior, above and below grade, concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve or hole. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.03 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls Above Grade:
 - a. Piping Smaller than NPS 4: Cast-iron wall sleeves, galvanized-steel wall sleeves, or galvanized-steel-pipe sleeves.
 - b. Piping NPS 4 and Larger: Cast-iron wall sleeves or galvanized-steel-pipe sleeves.
 - 2. Exterior Concrete Walls Below Grade:
 - a. Piping Smaller than NPS 4: Cast-iron wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 4 and Larger: Cast-iron wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 3. Concrete Foundation or Stem Walls Below Grade:
 - a. Piping Smaller than NPS 4: Cast-iron wall sleeves.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve.
 - b. Piping NPS 4 and Larger: Cast-iron wall sleeves.

4. Concrete Slabs-on-Grade: Cast-iron wall sleeves with sleeve-seal system.
 - a. Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
5. Concrete Slabs Above Grade: Galvanized-steel-pipe sleeves.
6. Interior Partitions:
 - a. Piping Smaller than NPS 6: Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION

Edition 0308-0715

SECTION 23 05 18

ESCUTCHEONS FOR HVAC PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 PRODUCTS

2.01 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and set screw fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw and polished chrome-plated finish.

2.02 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- B. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Insulated Piping: One-piece, stamped-steel type.
 - c. Bare Piping: One-piece, cast-brass type.
 - 2. Escutcheons for existing piping shall be split-casting, cast-brass type.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. New Piping: One-piece, floor-plate type,
 - 2. Existing Piping: Split-casting, floor-plate type.

3.02 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION

Edition 0308-1109

SECTION 23 05 20

ELECTRICAL & CONTROL WIRING FOR MECHANICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. This section is to be used for all low- and line-voltage wiring for mechanical controls. All line-voltage work shall be performed by a licensed contractor qualified to perform the work and shall comply with the requirements contained in this section or in Division 26.
- B. This section does not apply to plenum rated cables used for electrically activated remote damper operators.
- C. This section includes the following:
 - 1. Metal conduits, tubing, and fittings.
 - 2. Non-metallic conduits, tubing, and fittings.
 - 3. Metal wireways and auxiliary gutters.
 - 4. Surface raceways.
 - 5. Boxes, enclosures, and cabinets.
 - 6. Low-voltage control cabling.
 - 7. Conductors and cables rated 600 volts and less.
 - 8. Connectors, splices, and terminations rated 600 volts and less.
 - 9. Identification of power and control cables.
 - 10. Identification for conductors.
 - 11. Underground-line warning tape.

1.02 DEFINITIONS

- A. Low-Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 volts or for remote-control and signaling power-limited circuits.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated, include manufacturer's technical data, materials of construction, and listings.
- B. Field quality-control test reports.
- C. Maintenance data.

1.04 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ), and marked for intended use.
- C. Comply with NFPA 70.
- D. Comply with ANSI A13.1 for identification devices.

PART 2 PRODUCTS

2.01 METAL CONDUITS, TUBING, AND FITTINGS

- A. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. GRC: Comply with ANSI C80.1 and UL 6.
- C. IMC: Comply with ANSI C80.6 and UL 1242.
- D. EMT: Comply with ANSI C80.3 and UL 797.
 - 1. Color: Factory-applied color per schedule below.
 - a. HVAC Control Wiring: White.
 - b. Power – Normal: Natural.
 - c. Power – Standby: Orange.
- E. FMC: Comply with UL 1; zinc-coated steel or aluminum.
- F. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- G. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
 - 2. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: Set screw or compression.
 - 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

- H. Joint Compound for IMC or GRC: Approved, as defined in NFPA 70, by the AHJ for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.02 NON-METALLIC CONDUITS, TUBING, AND FITTINGS

- A. Listing and Labeling: Non-metallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- C. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

2.03 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Sheet metal, complying with UL 870 and NEMA 250; Type 1, Type 3R, Type 4 or Type 12, as required by location; and sized according to NFPA 70.
 - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.04 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Where installed in finished spaces, match color of adjacent surfaces.

2.05 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

- B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Box extensions used to accommodate new building finishes shall be of the same material as the recessed box.
- D. Device Box Dimensions: 4 inches square by 2-1/8 inches deep or 4 inches by 2-1/8 inches by 2-1/8 inches deep.
- E. Gangable boxes are prohibited.
- F. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250; Type 1, Type 3R, Type 4 or Type 12, as required by location; with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- G. Cabinets:
 - 1. NEMA 250; Type 1, Type 3R or Type 12, as required by location; galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.

2.06 LOW-VOLTAGE CONTROL CABLE

- A. Paired Cable: NFPA 70, Type CMG.
 - 1. One pair, twisted, #16 or #18 AWG, stranded (19x29) tinned-copper conductors.
 - 2. PVC insulation.
 - 3. Unshielded.
 - 4. PVC jacket.
 - 5. Flame Resistance: Comply with UL 1581.
- B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
 - 1. One pair, twisted, #16 or #18 AWG, stranded (19x29) tinned-copper conductors.
 - 2. PVC insulation.
 - 3. Unshielded.
 - 4. PVC jacket.
 - 5. Flame Resistance: Comply with NFPA 262.

2.07 CONDUCTORS AND CABLES

- A. Copper Conductors: Comply with NEMA WC 70.
- B. Conductor Insulation: Comply with the following:
 - 1. NEMA WC 70 for Types THHN-THWN and XHHW.
 - 2. UL 83 for Types TW and TF.

2.08 CONNECTORS AND SPLICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. 3M; Electrical Products Division.
 - 2. AFC Cable Systems, Inc.
 - 3. Hubbell Power Systems, Inc.
 - 4. O-Z/Gedney; EGS Electrical Group LLC.
 - 5. Tyco Electronics Corp.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.09 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of cable it identifies and to stay in place by gripping action.
- D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of cable it identifies and to stay in place by gripping action.

2.10 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

- C. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.11 UNDERGROUND-LINE WARNING TAPE

- A. Tape:
 - 1. Recommended by the manufacturer for the method of installation and suitable to identify and locate underground electrical and control lines.
 - 2. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - 3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
- B. Color and Printing:
 - 1. Comply with ANSI Z535.1 through ANSI Z535.5.
 - 2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
 - 3. Inscriptions for Orange-Colored Tapes: CONTROL CABLE.
- C. Tag: Type ID:
 - 1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 - 2. Overall Thickness: 5 mils.
 - 3. Foil Core Thickness: 0.35 mil.
 - 4. Weight: 28 lb./1,000 sq. ft.
 - 5. 3-Inch Tensile According to ASTM D882: 70 lbf and 4,600 psi.

PART 3 EXECUTION

3.01 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
 - 1. Exposed Conduit: GRC or IMC.
 - 2. Concealed Conduit, Aboveground: GRC, IMC, or EMT.
 - 3. Underground Conduit: RNC, Type EPC-40-PVC or Type EPC-80-PVC, direct buried or concrete encased.
 - 4. Connection to Vibrating Equipment (Including Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

- B. Indoors: Apply raceway products as specified below unless otherwise indicated.
 - 1. Exposed, Not Subject to Physical Damage: EMT.
 - 2. Exposed, Not Subject to Severe Physical Damage: EMT.
 - 3. Exposed and Subject to Severe Physical Damage: GRC or IMC.
Raceway locations include the following but not limited to:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Gymnasiums.
 - 4. Concealed in Interior Walls and Partitions: EMT.
 - 5. Concealed Above or In Ceilings: EMT.
 - 6. Connection to Vibrating Equipment (Including Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 - 7. Damp or Wet Locations: GRC or IMC.
 - 8. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Raceway Size: Trade size 3/4 inch.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
 - 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 - 2. EMT: Use set screw or compression, steel fittings. Comply with NEMA FB 2.10.
 - 3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Do not install aluminum conduit, boxes, or fittings in contact with concrete or earth.
- F. Install surface raceways only in retrofit applications where indicated.

3.02 RACEWAY INSTALLATION

- A. Install all cabling, conductors, and wiring in raceways except where noted otherwise on the drawings or in other sections.
- B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on the drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

- C. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- D. Comply with requirements in Specification Section 23 05 29, Hangers and Supports for HVAC Piping and Equipment, for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Support conduit within 12 inches of enclosures to which attached.
- I. Raceways Embedded in Slabs:
 - 1. Run conduit larger than 1 inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Arrange raceways to keep a minimum of 1 inch of concrete cover in all directions.
 - 4. Do not embed threadless fittings in concrete unless specifically approved by the Engineer for each specific location.
- J. Stub-Ups to Above Recessed Ceilings:
 - 1. Use EMT, IMC, or GRC for raceways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- L. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than #4 AWG.
- M. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb. tensile strength. Leave at least 12 inches

of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

N. Surface Raceways:

1. Install surface raceway with a minimum 2-inch radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

O. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces.

P. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where conduits pass from humidity controlled spaces to non-humidity controlled spaces.
3. Where an underground service raceway enters a building or structure.
4. Where otherwise required by NFPA 70.

Q. Expansion-Joint Fittings:

1. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
2. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

R. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 48 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for motors.

1. Use FMC in indoor, dry locations.
2. Use LFMC in all other locations.

S. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

T. Locate boxes so that cover or plate will not span different building finishes.

- U. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- V. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

3.03 INSTALLATION OF UNDERGROUND CONDUIT

- A. Direct-Buried Conduit:
 - 1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 specifications for pipe less than 6 inches in nominal diameter.
 - 2. Install backfill as specified in Division 31 specifications.
 - 3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 specifications.
 - 4. Install manufactured rigid steel conduit elbows for stub-ups at equipment and at building entrances through floor.
 - a. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

3.04 CONDUCTOR MATERIAL APPLICATIONS

- A. Control Circuit Sizing: Minimum sizes are listed below:
 - 1. Class 1 remote-control and signal circuits, #14 AWG.
 - 2. Class 2 low-energy, remote-control, and signal circuits, #16 AWG.
 - 3. Class 3 low-energy, remote-control, alarm, and signal circuits, #12 AWG.
- B. Branch Circuits: Copper. Solid for #10 AWG and smaller; stranded for #8 AWG and larger.
- C. Branch Circuit Sizing: Size conductors for circuits with less than a 20 ampere connected load, maximum of 16 amperes actual load, as follows:
 - 1. For 120-volt circuits up to 65 feet in length from panel to center of load: Not smaller than No. 12.
 - 2. For 120-volt circuits up to 110 feet in length from panel to center of load: Not smaller than No. 10.

3. For 120-volt circuits up to 165 feet in length from panel to center of load:
Not smaller than No. 8.
4. For 120-volt circuits up to 255 feet in length from panel to center of load:
Not smaller than No. 6.
5. For 208-volt circuits up to 110 feet in length from panel to center of load:
Not smaller than No. 12.
6. For 208-volt circuits up to 185 feet in length from panel to center of load:
Not smaller than No. 10.
7. For 208-volt circuits up to 280 feet in length from panel to center of load:
Not smaller than No. 8.
8. For 208-volt circuits up to 440 feet in length from panel to center of load:
Not smaller than No. 6.
9. For 277-volt circuits up to 150 feet in length from panel to center of load:
Not smaller than No. 12.
10. For 277-volt circuits up to 250 feet in length from panel to center of load:
Not smaller than No. 10.
11. For 277-volt circuits up to 380 feet in length from panel to center of load:
Not smaller than No. 8.
12. For 277-volt circuits up to 590 feet in length from panel to center of load:
Not smaller than No. 6.

3.05 CONDUCTOR INSULATION APPLICATIONS AND WIRING METHODS

- A. Comply with NECA 1.
- B. Exposed Branch Circuits, including in Crawlspace: Type THHN-THWN or XHHW, single conductors in raceway.
- C. Branch Circuits Concealed in Walls, and Partitions: Type THHN-THWN or XHHW, single conductors in raceway.
- D. Branch Circuits Concealed Above or in Ceilings: Type THHN-THWN or XHHW, single conductors in raceway.
- E. Branch Circuits Concealed Above Lay-In Ceilings: Type THHN-THWN or XHHW, single conductors in raceway.
- F. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN or XHHW, single conductors in raceway.
- G. Class 1 and 2 Control Circuits: Type THHN-THWN or XHHW, in raceway unless noted otherwise.
 1. Final raceway connections for low-voltage control wiring to equipment, actuators and similar devices may be omitted where the devices are located above lay-in ceilings. Length of exposed wire is to be less than 24 inches.

- H. Class 3 Control Circuits: Type TW or TF in raceway unless noted otherwise.
 - 1. Final raceway connections for low-voltage control wiring to equipment, actuators and similar devices may be omitted where the devices are located above lay-in ceilings. Length of exposed wire is to be less than 24 inches.
- I. Open-Cable Installation: For control circuit wiring installed above lay-in ceilings where permitted in other sections:
 - 1. Install parallel and perpendicular to surfaces of exposed structural members.
 - 2. Suspend copper cable not in a conduit or wireway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
 - 3. Cables shall be supported by rings and bails and shall be neatly bunched, bundled and tied together.
 - 4. Cable shall not be run through structural members or in contact with conduit, pipes, ducts, or other potentially damaging items.
 - 5. Cables shall not be supported from ductwork, piping, plumbing systems, ceiling tile and lighting fixture suspension wires, or building structure.
 - 6. Low-voltage open wiring shall not be routed in or through data/telecommunication or other cabling raceways, conduits, cable trays, sleeves, etc.
 - 7. Plenum-rated cable ties and cable supports must be utilized in all plenum-rated spaces. Electrical tape is not acceptable as a cable tie, and cable ties are not acceptable as cable supports.
 - 8. All cables shall be free of tension at both ends, as well as over the entire length of the run.
 - 9. Cable ties and supports shall not pinch, bind, crimp, or in any way cause physical or electrical characteristic damage to the cabling.
 - 10. The Contractor shall assure that during and upon completion of the installation, all cables are free of kinks, sharp bends, twists, gouges, cuts, or any other physical damage.
 - 11. Cables shall be routed and supported away from building structure and system components, with a minimum clearance of 3 inches.

3.06 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal raceways and cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.

- D. Install raceways and exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Support cables according to Specification Section 23 05 29, Hangers and Supports for HVAC Piping and Equipment.
- F. Identify and color-code conductors and cables.
- G. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- H. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

3.07 IDENTIFICATION INSTALLATION

- A. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by the manufacturer of the identification device.
- C. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6-8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

3.08 IDENTIFICATION SCHEDULE

- A. Power-Circuit Conductor Identification, 600 Volts or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
 - 1. Color-Coding for Phase and Voltage Level Identification, 600 Volts or Less: Use colors listed below for ungrounded branch-circuit conductors.
 - a. Color shall be factory applied.
 - b. Colors for 208/120-Volt Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral: White.
 - c. Colors for 480/277-Volt Circuits:
 - 1) Phase A: Brown.

- 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral: Gray.
- B. Control Systems Conductor Identification: Identify field-installed control, and signal connections.
1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 2. Use system of marker tape designations that is uniform and consistent with the system used by the manufacturer for factory-installed connections.
 3. Coordinate identification with the Project Drawings, manufacturer's wiring diagrams, and the Operation & Maintenance Manual.
- C. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
1. Install underground-line warning tape for both direct-buried cables and cables in raceway.

3.09 REMOVAL OF CONDUCTORS AND CABLES

- A. Remove abandoned conductors and cables.

3.10 GROUNDING

- A. For low-voltage wiring and cabling, comply with requirements in Division 26.

3.11 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Specification Section 23 05 17, Sleeves and Sleeve Seals for HVAC Piping.

3.12 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Comply with requirements in Division 07 specifications.

3.13 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
1. Repair damage to galvanized finishes with zinc-rich paint recommended by the manufacturer.
 2. Repair damage to paint finishes with matching touchup coating recommended by the manufacturer.

3.14 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections: Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- C. Test Reports: Prepare a written report to record the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

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SECTION 23 05 29

HANGERS & SUPPORTS FOR HVAC PIPING & EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Thermal-hanger shield inserts.
 - 4. Fastener systems.
 - 5. Equipment supports.
 - 6. Non-penetrating rooftop bases.

1.02 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water with no load transmitted to connected equipment.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include product data for components:
 - 1. Trapeze pipe hangers.
 - 2. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by a qualified professional engineer responsible for their preparation.
- D. Welding certificates.

1.04 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, Structural Welding Code - Steel.
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Surface-Burning Characteristics: For tapes, as determined by testing identical products according to ASTM E84, by a testing agency acceptable to the Authorities Having Jurisdiction. Factory-label tapes with appropriate markings of the applicable testing agency.
 - 1. Tape Installed in Return Plenums: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Tape Installed Elsewhere: No testing requirement.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers shall be one of the following unless noted otherwise:
 - 1. Anvil International.
 - 2. B-Line Systems.
 - 3. Elgen.
 - 4. Kin-Line.
 - 5. Michigan Hanger Co.
 - 6. National Pipe Hanger Corp.
 - 7. PHD Manufacturing.
 - 8. PHS Industries.
 - 9. Pipe Technology and Products.
 - 10. Unistrut.

2.02 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
 - 3. Non-Metallic Coatings: Plastic coating, jacket, or liner.
 - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.

- B. Stainless-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
- C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- D. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

2.03 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, pipe clamps, and U-bolts.

2.04 THERMAL-HANGER SHIELD INSERTS

- A. Insulation-Insert Material for Hot or Cold Piping: ASTM C552, Type II cellular glass with 100-psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- B. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- C. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- D. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.
- E. Shield: Shields shall be a minimum of 18 gauge galvanized steel, 12 inches long for piping 6 inches and smaller. Shields shall be a minimum of 16 gauge galvanized steel, 18 inches long for pipe over 6 inches.

2.05 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.06 NON-PENETRATING ROOFTOP BASES

- A. Subject to compliance with requirements, manufacturers shall be one of the following:
 - 1. Dymotek.
 - 2. Miro Industries, Inc.
 - 3. PHP Systems Design.
- B. Description: Stainless-steel or polycarbonate bases designed for direct placement on roofing membrane.
 - 1. General:
 - a. All edges and corners in contact with the roof surface shall be rounded to prevent damage to the roof membrane.
 - b. Drainage ports shall be provided to prevent ponding of water within the base.
 - c. The bottom of the base shall be solid and flat, free of voids and deformities to prevent concentrated loading of the roofing membrane.
 - d. Polycarbonate bases shall be UV stabilized with carbon black.
 - 2. Supports: Pipe, conduit, duct, and equipment supports mounted to roof bases shall be constructed as outlined above. Integral supports for small diameter piping and conduit may be integral with polycarbonate bases.
 - 3. Protective Pads: 1/8-inch-thick, flexible PVC with carbon black additive for UV stabilization, protective pad for placement beneath roof bases to protect roofing membrane.

2.07 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and non-metallic grout; suitable for interior and exterior applications.
 - 1. Properties: Non-staining, non-corrosive, and non-gaseous.
 - 2. Design Mix: 5,000-psi, 28-day compressive strength.
- C. Tape for Plenum Use:
 - 1. Polypropylene backing with acrylic adhesive, Hart & Cooley Part No. 011371.
 - 2. Polyethylene-coated cloth backing with rubber adhesive, Uline Black Nashua 398 Duct Tape, Model No. S-17236BL.

PART 3 EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-58 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Hanger Sizing: Size hangers on insulated piping to fit outside of covering.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation: Install fasteners in strict accordance with manufacturer's written instructions.
- F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- M. Insulated Piping: Thermal-hanger shield inserts shall be used. Install with insulation the same thickness as piping insulation. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
- N. Conduit Support Installation:
 - 1. Comply with NECA 1 and NECA 101 for installation requirements, except as specified in this article.
 - 2. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
 - 3. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lbs.

3.02 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead, or to support equipment above floor or roof.
- B. Grouting: Place non-shrink grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.03 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.04 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.05 PAINTING

- A. Refer to General Provisions for rust inhibiting primer.
- B. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use the same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- C. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 specifications.
- D. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

3.06 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in sections specifying piping systems and equipment.
- B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system sections.
- C. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.
- D. Use hangers and supports with galvanized metallic coatings for piping and equipment that is exposed to weather and that will not have field-applied finish.
- E. Use stainless-steel pipe hangers and stainless-steel attachments for corrosive atmospheres.

- F. Wrap copper piping with not less than two layers of 10-mil-thick black plastic tape extending a minimum of 1 inch on each side of clamp for electrolytic protection where hangers or supports are in direct contact with copper piping.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal-hanger shield inserts for insulated piping and tubing.
- I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1,050°F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 1-1/2 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 - 5. Single-Pipe Rolls (MSS Type 43): For suspension of pipes NPS 1 to NPS 30, with one rod if longitudinal movement caused by expansion and contraction might occur.
 - 6. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 - 7. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
- J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- K. Conduit Support Applications:
 - 1. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical conduit.
 - 2. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
 - 3. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel-slotted or other support system, sized so capacity can be

increased by at least 25% in future without exceeding specified design load limits.

- a. Secure raceways and cables to these supports with two-bolt conduit clamps or single-bolt conduit clamps.
- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system sections, install the following types:
1. Steel Turnbuckles (MSS Type 13).
 2. Steel Clevises (MSS Type 14): For 120 to 450°F piping installations.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape. Include retaining clip.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes. Include retaining clip.
 7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lbs.
 - b. Medium (MSS Type 32): 1,500 lbs.
 - c. Heavy (MSS Type 33): 3,000 lbs.
 8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- N. Roof Bases: Unless otherwise indicated install roof bases for roof-mounted piping, conduit, ductwork, and equipment as follows:
1. Select roof base size based on expected load to prevent crushing of the roofing membrane and underlying insulation.
 2. Space roof bases as required to properly support conduit, pipes, or ducts, or more frequently to distribute the weight of the supported systems to prevent damage to the roofing membrane, underlying insulation, or roofing system.

3. Provide protective pads between each roof base and the roofing membrane. Size pads to extend a minimum of 2 inches beyond each roof base.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system sections, install the following types:
 1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
- P. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system sections.

END OF SECTION

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SECTION 23 05 48.13

VIBRATION CONTROLS FOR HVAC PIPING & EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes the following:
 - 1. Isolation pads.
 - 2. Spring hangers.

1.02 DEFINITIONS

- A. Sound Critical: Assembly spaces such as classrooms, auditoriums, etc.; normally occupied rooms such as offices, call centers, etc.; vibration critical areas such as data rooms, technical manufacturing areas, etc.; or other areas as indicated.
- B. Non-Sound Critical: Not normally occupied areas such as storage rooms, electrical rooms, mechanical yards, commercial kitchens, scullery areas, etc.

1.03 SUBMITTALS

- A. Product Data: For each product indicated.
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
- B. Welding certificates.
- C. Field quality-control test reports.

1.04 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, Structural Welding Code - Steel.

PART 2 PRODUCTS

2.01 VIBRATION ISOLATORS

- A. Manufacturers: The following products are based on Mason Industries. Subject to compliance with requirements, provide comparable products by one of the following:
 - 1. Amber/Booth Company, Inc.

2. Kinetics Noise Control.
 3. Mason Industries.
 4. Vibration Mountings & Controls, Inc.
- B. Neoprene Pad: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a non-slip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
1. Resilient Material: Oil- and water-resistant neoprene.
- C. Style F - Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80% of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50% of the required deflection at rated load.
 4. Lateral Stiffness: More than 80% of rated vertical stiffness.
 5. Overload Capacity: Support 200% of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Elements: Molded, oil-resistant rubber or neoprene.
 - a. Minimum 1-1/4-inch-thick element at top of hanger with steel-washer-reinforced rod support and bushing projecting through top of frame.
 - b. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

2.02 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled equipment before shipping.
1. Powder coating on springs and housings.
 2. All hardware shall be zinc electroplated.
 3. Baked enamel or powder coat for metal components on isolators for interior use.
 4. Color-code or otherwise mark vibration isolation control devices to indicate capacity range.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Engage a factory-authorized representative to inspect the intended equipment locations for deficiencies and to instruct installers in correct equipment installation procedure and sequence.
- B. Examine areas and equipment to receive vibration isolation devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- C. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits.
- C. Select vibration isolation elements and deflections in accordance with the following table:

Equipment	Location	Vibration Isolation Element (Minimum Deflection)
Condensing Unit	Slab Not On-Grade	Neoprene Pad ≤ 20 Tons
Indoor Units	Suspended	Style F (0.75 inches ≤ 5 HP)

3.03 VIBRATION-CONTROL INSTALLATION

- A. Install bushing assemblies for mounting bolts for vibration isolated wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- B. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

C. Drilled-In Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the Structural Engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

D. Riser Isolation: Suspended risers with spring hangers or supported with spring mounts, anchored with piping anchors, and guided with sliding guides.

1. Suspend horizontal pipe runs and branches with spring hangers for the first three supports from the risers.
2. Steel springs shall be selected to provide a minimum of 3/4-inch static deflection except in those expansion locations where additional deflection is required to limit load changes to +25% of the initial load.

E. Short-Circuiting: Avoid short-circuiting to the building any vibration-isolated piece of equipment, pipe, duct or other component. Short-circuits with or via rigid conduits, drain lines, rigid braces, rigid sleeves, framing, etc., shall all be avoided. The Contractor shall oversee trades to prevent the short-circuiting of any vibration isolation system and shall bring any unresolved conflicts to the Engineer's attention.

F. Incidentals: Supply and install any incidental equipment or parts needed to meet the requirements stated, even if not specified or shown on the drawings.

3.04 ADJUSTING

A. Adjust isolators after piping system is at operating weight and temperature.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

- C. Adjust active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.05 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Engage a factory-authorized representative to inspect the completed installation prior to the closing in of any unfinished work and again at the completion of the project. Complete any corrective work identified during the inspection.
- C. Tests and Inspections:
 - 1. Measure isolator restraint clearance.
 - 2. Measure isolator deflection.
 - 3. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

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SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING & EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.

1.02 SUBMITTAL

- A. Product Data: For each type of product indicated.

PART 2 PRODUCTS

2.01 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multi-layer, multi-color plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: Black.
 - 3. Background Color: White.
 - 4. Maximum Temperature: Able to withstand temperatures up to 160°F.
 - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 inches by 3/4 inch.
 - 6. Minimum Letter Size: 1/2 inch. Include secondary lettering 3/8 inch.
 - 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 - 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's drawing designation or unique equipment number, and area(s) served by equipment. Coordinate with the Owner.

2.02 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multi-layer, multi-color plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Red.

- D. Maximum Temperature: Able to withstand temperatures up to 160°F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 inches by 3/4 inch.
- F. Minimum Letter Size: 1/2 inch. Include secondary lettering 3/8 inch.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: As indicated on the drawings or required by the local authority.

2.03 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
 - 1. Complying with latest edition of ANSI/ASME A13.1 unless specifically noted otherwise or directed by the Owner.
- B. Pretensioned Pipe Labels: Precoiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Strap-On Pipe Labels: Semi-rigid plastic formed to fit circumference of pipe and to attach to pipe with stainless-steel worm-drive clamps.
- D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent adhesive backing.
- E. Pipe Label Contents: Include identification of piping service using the same designations or abbreviations as used on the drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.

2.04 PAINTED PIPE AND DUCT LABELS

- A. Paint: Alkyd paint selected for use without a primer based on base material.
- B. Color: Match background color indicated in Label Color Schedules below.
- C. Application: Use stencils for paint application.
- D. Lettering Size: At least 3 inches high.

- E. Flow Arrows: To show flow direction.

PART 3 EXECUTION

3.01 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.03 PIPE LABEL INSTALLATION

- A. Comply with requirements in latest edition of ANSI/ASME 13.1 unless noted otherwise.
- B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 20 feet along each run. Reduce intervals to 10 feet in areas of congested piping and equipment. Reduce spacing to 5 feet when required by code.
 - 7. Spaced at maximum 10 feet on piping above removable acoustical ceilings. Reduce spacing to 5 feet when required by code.
- C. Use painted pipe labels outside where piping is exposed to weather.
 - 1. Apply one or two coats using the same stencil as required for thorough coverage.

- D. Pipe Label Color Schedule:
 - 1. Condensate Drain Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.
 - 2. Refrigerant Piping:
 - a. Background Color: Yellow.
 - b. Letter Color: Black.

3.04 ADJUSTING AND CLEANING

- A. Relocate mechanical identification materials and devices that have become visually blocked by other work.
- B. Clean faces of mechanical identification devices.

END OF SECTION

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SECTION 23 05 93

TESTING, ADJUSTING & BALANCING FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes:
 - 1. Balancing Air Systems.
 - 2. Balancing HVAC Equipment.
 - 3. Testing, Adjusting and Balancing Existing HVAC Systems.

1.02 APPROVED CONTRACTORS

- A. Engage the services of one of the following:
 - 1. Able Air Balance, LLC.
 - 2. ABM Building Services, LLC., Phoenix, Arizona Balance Division.
 - 3. Arizona Air Balance Co.
 - 4. Phoenix Test and Balance, LLC.
 - 5. Precision Air.
 - 6. Southwest Testing and Balancing, LLC.
 - 7. Systems Commissioning & Testing, Inc.
 - 8. TAB Technology, Inc.
 - 9. Technical Air Balance.

1.03 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TAB Specialist: An entity engaged to perform TAB work.

1.04 SUBMITTALS

- A. Contractor Qualifications: Include AABC or NEBB certificates for proposed personnel, test instrument certifications.
- B. Certified TAB reports.
- C. Sealed special inspection reports.

1.05 QUALITY ASSURANCE

- A. Supervising technicians and firm shall be AABC or NEBB certified.
- B. Certify TAB field data reports and perform the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - 2. Certify that the TAB team complied with the TAB plan and the procedures specified and referenced in this Specification.
- C. TAB Report Forms: Use standard TAB Contractor's forms.
- D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, Instrumentation.
- E. Perform special inspections as required herein and by the AHJ.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine the Contract Documents and approved submittals for the HVAC systems and equipment to become familiar with project requirements and to discover conditions in system designs that may preclude proper TAB of systems and equipment or inefficient operation. Report findings and recommendations directly to the Engineer within 30 days of document review.
- B. Examine ceiling plenums used for return or relief air to verify that there is a proper path for return and relief air from all areas of the building. Verify that penetrations through walls between plenum and non-plenum areas are sealed.
- C. Examine equipment performance data including fan curves. Relate performance data to project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- D. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, filters are clean and in place, and equipment with functioning controls is ready for operation.
- E. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- F. Examine operating safety interlocks and controls on HVAC equipment.

- G. Report deficiencies discovered before and during performance of TAB procedures directly to the Engineer and Mechanical Contractor. Observe and record system reactions to changes in conditions. Record default setpoints if different from indicated values.
- H. The General or Mechanical Contractor shall not in any way prohibit the TAB Contractor from communicating directly and freely with the Engineer. The TAB Contractor is required to copy the Engineer on all communications to the Contractor.

3.02 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify the following:
 - 1. Permanent electrical-power wiring is complete.
 - 2. Automatic temperature-control systems are operational.
 - 3. Equipment and duct access doors are securely closed.
 - 4. Balance, smoke, and fire dampers are open.
 - 5. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 - 6. Windows and doors can be closed so indicated conditions for system operations can be met.

3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's National Standards for Total System Balance or NEBB's Procedural Standards for Testing Adjusting and Balancing of Environmental Systems, and in this section.
 - 1. Comply with requirements in ASHRAE 62.1, Section 7.2.2, Air Balancing.
- B. Cut insulation and ducts for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts airtight.
 - 2. Coordinate with the Mechanical Contractor to restore insulation, coverings, vapor barrier, and finish according to Division 23 sections.
- C. Mark equipment and balancing devices, including damper-control positions, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

3.04 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of

required outlet volumes with required fan volumes. Correct variations that exceed $\pm 10\%$.

- B. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- C. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- D. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- E. Verify that motor starters are equipped with properly sized thermal protection.
- F. Check dampers for proper position to achieve desired airflow path.
- G. Check for airflow blockages.
- H. Check condensate drains for proper connections.
- I. Check for proper sealing of air-handling-unit components.
- J. Verify that joints and seams in air duct systems are sealed as specified in Division 23 sections.

3.05 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by the fan manufacturer.
 - 1. Measure Total Airflow: Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
 - 2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment. Exception: Individual component measurement is not required for unitary equipment 5 tons and less in capacity. Provide external static pressure measurement across unit only.
 - a. Report the cleanliness status of filters and the time static pressures are measured.
 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
 7. Instruct the Mechanical Contractor to replace fan and motor sheaves and belts as required to achieve design airflow or pressurization.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
1. Measure airflow of submain and branch ducts.
 - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
 3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
 4. Instruct the Mechanical Contractor to install manual volume dampers where required to achieve proper air balance.
- C. Measure air outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in the same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.06 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 1. Manufacturer's name, model number, and serial number.
 2. Motor horsepower rating.
 3. Motor rpm.
 4. Efficiency rating.
 5. Nameplate and measured voltage, each phase.
 6. Nameplate and measured amperage, each phase.
 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Set minimum motor speed to 20%. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.07 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

3.08 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each refrigerant coil:
 1. Dry-bulb temperature of entering and leaving air.
 2. Wet-bulb temperature of entering and leaving air.
 3. Airflow.
 4. Air pressure drop.

3.09 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

- A. Perform a preconstruction inspection of existing equipment that is to remain and be re-used.
 1. Measure and record the operating speed, airflow, and static pressure of each fan.

2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
 3. Measure and record the refrigerant charge.
 4. Measure and record the waterflow through water coils.
 5. Check the condition of filters.
 6. Check the condition of coils.
 7. Check the operation of the drain pan and condensate-drain trap.
 8. Check bearings and other lubricated parts for proper lubrication.
 9. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.
- B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be re-used to verify that existing equipment has been cleaned and refurbished. Verify the following:
1. New filters are installed.
 2. Coils are clean and fins combed.
 3. Drain pans are clean.
 4. Fans are clean.
 5. Bearings and other parts are properly lubricated.
 6. Deficiencies noted in the preconstruction report are corrected.
- C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
 2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by the equipment manufacturer.
 3. If calculations increase or decrease the airflow rates and waterflow rates by more than 5%, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5% or less, equipment adjustments are not required.
 4. Balance each air outlet.

3.10 TOLERANCES

- A. Set HVAC system's airflow rates within the following tolerances:
1. Supply, Return, and Exhaust Fans and Equipment with Fans: $\pm 10\%$.
 2. Air Outlets and Inlets: $\pm 10\%$.

3.11 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in the Examination article, prepare a report on the adequacy of design for system balancing devices. Recommend changes and

additions to system balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

3.12 OUTDOOR AIR SUMMARY REPORT

- A. Prepare a summary report for review by the AHJ that lists each supply-air system on the project. The report shall indicate the system or equipment designation, the scheduled outdoor-airflow rate and the balanced outdoor-airflow rate.

3.13 SPECIAL INSPECTIONS

- A. Prepare special inspection reports, signed and sealed by a professional engineer, as required by the AHJ or as required above.

3.14 FINAL REPORT

- A. General: Prepare certified reports in both paper and PDF format; tabulate and divide the report into separate sections for tested systems and balanced systems. Submit three copies of paper reports and one copy of report in PDF format.
 - 1. Assemble paper reports in 3-ring binders. Separate and order sections within each binder. Provide labeled tabs at each section with a table of contents at the front of the binder. The table of contents shall indicate the tab number and the information contained at that tab.
 - 2. Assemble PDF report in one PDF file. Separate and order sections within the file to match the paper copy. Provide bookmarks at the first page of each section and label each bookmark with the information contained in that section. Submit on digital media acceptable to the Engineer.
- B. Final Report Contents: In addition to certified field-report data, include the following:
 - 1. Pump curves.
 - 2. Fan curves.
 - 3. Other information relative to equipment performance; do not include shop drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 - 1. Title page.
 - 2. Name and address of the TAB Contractor.
 - 3. Project name.
 - 4. Project location.
 - 5. Engineer's name and address.

6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Certification sheet signed and sealed by the certified Testing & Balancing Engineer.
11. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
12. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
13. Nomenclature sheets for each item of equipment.
14. Data for terminal units, including manufacturer's name, type, size, and fittings.
15. Notes to explain why certain final data in the body of reports vary from indicated values.
16. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Variable frequency drive settings including maximum and minimum setpoints.
 - g. Inlet vane settings for variable-air-volume systems.
 - h. Settings for supply-air, static-pressure controller.
 - i. Other system operating conditions that affect performance.
17. Include a list of instruments used for procedures, along with proof of calibration.
18. Submit a preliminary, electronic copy of the final report to the Engineer for review.
19. Make any corrections noted from the Engineer's review upon receipt of comments and resubmit as required.
20. Submit the final, corrected report in electronic format to the Engineer and in both paper and electronic format to the Engineer.

3.15 ADDITIONAL TESTS

- A. TAB Report Verification: The TAB Specialist may be required to recheck, in the presence of the Owner's representative, specific or random selections of data recorded in the certified report. Points and areas for recheck shall be

selected by the Owner's representative. Measurements and test procedures shall be the same as approved for the initial work for the certified report. Selections for verification, specific plus random, will not exceed 10% of the total number of measurements tabulated in the report. If the values measured during the verification process exceed $\pm 10\%$ of the values recorded in the report, the TAB Specialist may be required to re-perform the TAB work outlined above.

END OF SECTION

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SECTION 23 07 13

DUCT INSULATION

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes duct exterior insulation systems.
- B. Related Sections:
 - 1. Refer to Specification Section 23 31 13, Metal Ducts, for duct liner.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated, include manufacturer's technical data with proposed thickness and R-value indicated, and application.

1.03 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84, by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ). Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 PRODUCTS

2.01 INSULATION MATERIALS

- A. Comply with requirements in the Duct Insulation Schedule article for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.
- E. All materials shall conform to NFPA 90A and NFPA 90B, ASHRAE 90.1 and the International Energy Construction Code (IECC).

- F. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type II and ASTM C1290, Type III with factory-applied FSK jacket composed of aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Bonded Logic Ultra-Touch.
 - b. CertainTeed Corp.; SoftTouch Duct Wrap.
 - c. Johns Manville; Microlite.
 - d. Knauf Insulation; Atmosphere Duct Wrap.
 - e. Manson Insulation Products Ltd.; Alley Wrap.
 - f. Owens Corning; SOFTR All-Service Duct Wrap.
- H. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IA or Type IB with factory-applied ASJ or FSK jacket.
 - 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
 - 2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
 - 3. Products: Subject to compliance with requirements, provide one of the following:
 - a. Bonded Logic Ultra-Touch.
 - b. CertainTeed Corp.; Commercial Board.
 - c. Johns Manville; 800 Series Spin-Glas.
 - d. Knauf Insulation; Earthwool Insulation Board.
 - e. Owens Corning; Fiberglas 700 Series.

2.02 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. PVC Jacket Adhesive: Compatible with PVC jacket.
 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.03 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below and above ambient services.
 1. Water-Vapor Permeance: ASTM E96/E96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
 2. Service Temperature Range: -20 to +180°F.
 3. Solids Content: ASTM D1644, 58% by volume and 70% by weight.
 4. Color: White.

2.04 SEALANTS

- A. FSK and Metal Jacket Flashing Sealants:
 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: -40 to +250°F.
 4. Color: Aluminum.
 5. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:
 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: -40 to +250°F.
 4. Color: White.

2.05 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 - 1. Adhesive: As recommended by the jacket material manufacturer.
 - 2. Color: White.
- C. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - 1. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
 - 2. Finish and thickness are indicated in field-applied jacket schedules.
 - 3. Moisture Barrier: 3-mil-thick, heat-bonded polyethylene and kraft paper or 2.5-mil-thick polysurlyn.
- D. Self-Adhesive Outdoor Jacket: 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with stucco-embossed aluminum-foil facing.

2.06 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
 - 1. Width: 3 inches.
 - 2. Thickness: 11.5 mils.
 - 3. Adhesion: 90 ounces force/inch in width.
 - 4. Elongation: 2%.
 - 5. Tensile Strength: 40 lbf/inch in width.
 - 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
 - 1. Width: 3 inches.
 - 2. Thickness: 6.5 mils.
 - 3. Adhesion: 90 ounces force/inch in width.
 - 4. Elongation: 2%.
 - 5. Tensile Strength: 40 lbf/inch in width.
 - 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
 - 1. Width: 2 inches.
 - 2. Thickness: 6 mils.
 - 3. Adhesion: 64 ounces force/inch in width.
 - 4. Elongation: 500%.
 - 5. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
 - 1. Width: 2 inches.
 - 2. Thickness: 3.7 mils.
 - 3. Adhesion: 100 ounces force/inch in width.
 - 4. Elongation: 5%.
 - 5. Tensile Strength: 34 lbf/inch in width.

2.07 SECUREMENTS

- A. Aluminum Bands: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide, with wing seal or closed seal.
- B. Stainless-Steel Bands: 0.015 inch thick, 1/2 inch wide, with wing seal or closed seal.
- C. Insulation Pins and Hangers:
 - 1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - b. Spindle: Copper- or zinc-coated, low carbon-steel, or stainless-steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive: Recommended by the hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
 - 2. Metal, Capacitor-Discharge-Weld Pin, Insulation Hangers: Copper-coated, low carbon-steel, or stainless-steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated. May be provided with base.
 - 3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized or stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

- a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
- 4. Metal, Cupped-Head, Capacitor-Discharge-Weld Pins:
 - a. Head: Galvanized, carbon-steel or stainless-steel sheet, minimum of 0.016 inch thick with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - b. Spindle: Copper- or zinc-coated, low carbon-steel, or stainless-steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.

D. Staples: Outward-clinching insulation staples, nominal 3/4 inch wide, stainless steel or Monel.

E. Wire: 0.062-inch, soft-annealed stainless steel.

2.08 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1-inch by 1-inch PVC according to ASTM D1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040-inch-thick, minimum 1-inch by 1-inch aluminum according to ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 EXECUTION

3.01 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.02 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch-wide strips, of the same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75% of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

- N. Repair damaged insulation facings by applying the same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.03 PENETRATIONS

- A. Insulation Installation at Interior Wall and Partition Penetrations (that are Not Fire Rated): Install insulation continuously through walls and partitions.
- B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
 - 1. Comply with requirements in Division 07 specifications for firestopping and fire-resistive joint sealers.

3.04 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
 - 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100% coverage of duct and plenum surfaces.
 - 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 - 3. Install either adhesively attached or capacitor-discharge-weld pins and speed washers, or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 - 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor

barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

- a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50°F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
 5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100% coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either adhesively attached or capacitor-discharge-weld pins and speed washers, or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal

seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

- a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50°F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.05 FIELD-APPLIED JACKET INSTALLATION

- A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by the insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.
 1. Cross-break or slope the top of all metal jackets mounted outside the building to promote drainage and to prevent ponding of water on top of the ductwork.

3.06 DUCT INSULATION SCHEDULE

- A. Duct, Plenums and Accessories Not Requiring Insulation:
 1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1. Refer to Specification Section 23 31 13, Metal Ducts, for duct lining requirements.
 2. Factory-insulated flexible ducts.

3. Factory-insulated plenums and casings.
4. Flexible connectors.
5. Vibration-control devices.
6. Factory-insulated access panels and doors.

- B. Duct and Plenum Insulation: Insulate ducts and plenums in accordance with the Duct and Plenum Insulation Schedule Table.

DUCT & PLENUM INSULATION SCHEDULE TABLE					
Duct/Plenum System	Duct Type	Duct Location**	Insulation Type	Minimum Insulation Density (PCF)	Minimum Insulation R-Value (Thickness)
Supply (non-evaporative cooled)	Round	Interior, Concealed	Mineral-Fiber Blanket	0.75	R-6 (2 inches)
Supply (non-evaporative cooled)	Round	within Return Air Plenum	Mineral-Fiber Blanket	0.75	R-5 (1-1/2 inches)
Supply (non-evaporative cooled)	Rectangular	Interior, Concealed	Duct Lining*	--	--
Return	Round	Interior, Concealed	Mineral-Fiber Blanket	0.75	R-6 (2 inches)
Return	Round	within Return Plenum	Mineral-Fiber Blanket	0.75	R-5 (1-1/2 inches)
Return & Exhaust	Rectangular	Interior, Concealed	Duct Lining*	--	--
* Refer to Specification Section 23 31 13, Metal Ducts, for liner requirements.					
** Interior means within the insulated building envelope. Exterior means outside the building envelope.					

3.07 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is the Contractor's option.
- C. Ducts and Plenums, Concealed: None.

3.08 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

- B. If more than one material is listed, selection from materials listed is the Contractor's option.
- C. Ducts and Plenums, Concealed: None.
- D. Ducts and Plenums, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
 - 1. Aluminum, Stucco Embossed: 0.020 inch thick.
- E. Ducts and Plenums, Exposed, Larger than 48 Inches in Diameter or with Flat Surfaces Larger than 72 Inches:
 - 1. Aluminum, Stucco Embossed with 1-1/4-Inch-Deep Corrugations: 0.040 inch thick.

END OF SECTION

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SECTION 23 07 19

HVAC PIPING INSULATION

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes insulating the following HVAC piping systems:
 - 1. Refrigerant piping.
 - 2. Condensate drain piping.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated, include manufacturer's technical data with proposed thickness and R-value indicated, and application.

1.03 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84, by a testing and inspecting agency acceptable to the Authorities Having Jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 PRODUCTS

2.01 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. All insulating materials shall conform to NFPA 90A and NFPA 90B, ASHRAE 90.1 and the International Energy Construction Code (IECC).
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type I for tubular materials.
1. Manufacturers: Subject to compliance with requirements, provide product by one of the following manufacturers:
 - a. Armacell LLC.
 - b. K-Flex USA
- G. Mineral-Fiber Insulation:
1. Manufacturers: Subject to compliance with requirements, provide product by one of the following manufacturers:
 - a. CertainTeed Corp.
 - b. Johns Manville.
 - c. Knauf Insulation.
 - d. Manson Insulation Products Ltd.
 - e. Owens Corning.
 2. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C1290, Type I.
 3. Mineral-Fiber, Pre-Formed Pipe Insulation:
 - a. Type I, 850°F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547, Type I, Grade A, with factory-applied ASJ or with factory-applied ASJ-SSL. Omit jacket on all but outermost layer where multiple insulation layers are required. Jacket shall comply with the following:
 - 1) ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
 - 2) ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
- H. Removable Insulation Wrap:
1. Manufacturers: Subject to compliance with requirements, provide product by the following: No Sweat.
 2. Removable Insulation Wrap:
 - a. Insert: Mineral or glass fibers bonded with a thermosetting resin with a minimum K-factor of 0.26 suitable for use up to 450°F. Maximum flame spread index of 25 and maximum smoke developed index of 50 per ASTM E84. Insert thickness to match thickness of adjacent insulation.
 - b. Outer Jacket: Tychem wrap consisting of Tyvek fabric made of spunbonded polyolefin with a polyethylene coating to limit vapor permeability. Jacket shall be provided with elastic banding at the ends and a reclosable hook and loop closure system at the seam. Maximum flame spread index of 25 and maximum smoke developed index of 50 per ASTM E84.

2.02 INSULATING CEMENTS

- A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.

2.03 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
 - 1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- D. ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
- E. PVC Jacket Adhesive: Compatible with PVC jacket.

2.04 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
 - 1. Water-Vapor Permeance: ASTM E96/E96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 2. Service Temperature Range: -20 to +180°F.
 - 3. Solids Content: ASTM D1644, 58% by volume and 70% by weight.
 - 4. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
 - 1. Water-Vapor Permeance: ASTM F1249, 1.8 perms at 0.0625-inch dry film thickness.
 - 2. Service Temperature Range: -20 to +180°F.
 - 3. Solids Content: 60% by volume and 66% by weight.
 - 4. Color: White.

2.05 SEALANTS

- A. Joint Sealants:
 - 1. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 3. Permanently flexible, elastomeric sealant.
 - 4. Service Temperature Range: -100 to +300°F.
 - 5. Color: White or gray.
- B. Metal Jacket Flashing Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: -40 to +250°F.
 - 4. Color: Aluminum.
- C. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: -40 to +250°F.
 - 4. Color: To match jacket.

2.06 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.

2.07 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 - 1. Adhesive: As recommended by the jacket material manufacturer.
 - 2. Color: White.
 - 3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

- a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, traps, and mechanical joints.
- C. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - 1. Sheet and roll stock ready for shop or field sizing, or factory cut and rolled to size.
 - 2. Finish and thickness are indicated in field-applied jacket schedules.
 - 3. Moisture Barrier for Indoor and Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
 - 4. Factory-Fabricated Fitting Covers:
 - a. The same material, finish, and thickness as jacket.
 - b. Pre-formed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - c. Tee covers.
 - d. Flange and union covers.
 - e. End caps.
 - f. Beveled collars.
 - g. Valve covers.
 - h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- D. Self-Adhesive Outdoor Jacket: 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with stucco-embossed aluminum-foil facing.

2.08 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
 - 1. Width: 3 inches.
 - 2. Thickness: 11.5 mils.
 - 3. Adhesion: 90 ounces force/inch in width.
 - 4. Elongation: 2%.
 - 5. Tensile Strength: 40 lbf/inch in width.
 - 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
 - 1. Width: 2 inches.
 - 2. Thickness: 6 mils.
 - 3. Adhesion: 64 ounces force/inch in width.
 - 4. Elongation: 500%.
 - 5. Tensile Strength: 18 lbf/inch in width.

- C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
 - 1. Width: 2 inches.
 - 2. Thickness: 3.7 mils.
 - 3. Adhesion: 100 ounces force/inch in width.
 - 4. Elongation: 5%.
 - 5. Tensile Strength: 34 lbf/inch in width.

2.09 SECUREMENTS

- A. Aluminum Bands: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
- B. Staples: Outward-clinching insulation staples, nominal 3/4 inch wide, stainless steel or Monel.
- C. Wire: 0.062-inch, soft-annealed stainless steel.

PART 3 EXECUTION

3.01 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.02 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Install insulation continuously through hangers and around anchor attachments.
- K. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
- L. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- M. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
- N. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- O. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch-wide strips, of the same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- P. Cut insulation in a manner to avoid compressing insulation more than 75% of its nominal thickness.

- Q. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- R. Repair damaged insulation facings by applying the same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- S. For above-ambient services, do not install insulation to the following:
 - 1. Items where insulation is prohibited by the manufacturer.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.
 - 6. Cleanouts.

3.03 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends below roof surface. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends inside building. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 - 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (that are Not Fire Rated): Install insulation continuously through walls and partitions.

- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Comply with requirements in Division 07 specifications for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
 - 1. Pipe: Install insulation continuously through floor penetrations.
 - 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 specifications for firestopping and fire-resistive joint sealers.
- G. Installation of Pipe Hangers and Rollers:
 - 1. Install thermal-hanger shield inserts complying with Specification Section 23 05 29, Hangers and Supports for HVAC Piping and Equipment, at all hangers and rollers.

3.04 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 - 2. Insulate pipe elbows using pre-formed fitting insulation or mitered fittings made from the same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with pre-formed fitting insulation or sectional pipe insulation of the same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using pre-formed fitting insulation or sectional pipe insulation of the same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 - 5. Insulate strainers using pre-formed fitting insulation or sectional pipe insulation of the same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two

times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized pre-formed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
 10. Contractor's Option for Valves, Strainers and Coil Connection Kits:
Removable insulation wrap system.
 - a. Below Ambient Systems or Where a Vapor Barrier is Specified:
 - 1) Provide PVC tape around ends of wrap system to seal wrap to adjacent pipe insulation.
 - 2) Provide PVC tape closure along seam. Center tape to overlap seam.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated and where required for maintenance. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of the same thickness as that on adjoining pipe. Install the same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in the same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.05 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
 1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section the same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of the same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
 1. Install mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
 1. Install pre-formed valve covers manufactured of the same material as pipe insulation when available.
 2. When pre-formed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.

4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- E. Insulation Installation on Flexible Bellow Connectors and Flexible Hoses:
 1. Install full and mitered sections of pipe insulation as required.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.06 INSTALLATION OF MINERAL-FIBER PRE-FORMED PIPE INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
 1. Secure each layer of pre-formed pipe insulation without jacket to pipe with wire or bands and tighten bands without deforming insulation materials.
 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
 4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
 1. Install pre-formed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section the same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
 1. Install pre-formed sections of the same material as straight segments of pipe insulation when available.
 2. When pre-formed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
 1. Install pre-formed sections of the same material as straight segments of pipe insulation when available.
 2. When pre-formed sections are not available, install mitered sections of pipe insulation to valve body.

3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.07 FIELD-APPLIED JACKET INSTALLATION

- A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.
 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal seams and end joints with weatherproof sealant recommended by the insulation manufacturer or if no sealant is recommended with silicone caulk. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.08 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable pre-formed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is the Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on pre-insulated underground piping.

3.09 INDOOR PIPING INSULATION SCHEDULE

- A. Refrigerant Suction Piping:
 1. Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch thick.
 - b. Mineral-Fiber, Pre-Formed Pipe Insulation: 1 inch thick.
- B. Refrigerant Suction Flexible Tubing: Flexible elastomeric, 1 inch thick.
- C. Air Conditioning Condensate Drain Piping: Flexible elastomeric, 3/4 inch thick.

3.10 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is the Contractor's option or as directed on the drawings.

- C. Piping, Concealed: None.
- D. Piping, Exposed:
 - 1. PVC: 30 mils thick.
 - 2. Aluminum, Stucco Embossed: 0.020 inch thick.

3.11 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is the Contractor's option.
- C. Piping, Concealed: None.
- D. Piping, Exposed:
 - 1. Aluminum, Corrugated or Stucco Embossed: 0.020 inch thick.

END OF SECTION

Edition 0908-0620

SECTION 23 21 15

HVAC DRAIN PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes pipe and fitting materials, and joining methods for HVAC drain piping including coil condensate drains.

1.02 PERFORMANCE REQUIREMENTS

- A. Drain piping components and installation shall be capable of withstanding 5 psig at 150°F.

1.03 SUBMITTALS

- A. Product Data: Include manufacturer's product literature indicating materials of construction, ratings, options, and accessories for each type of the following:
 - 1. Pipe and fittings.
- B. Field quality-control test reports.

1.04 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME B31.9, Building Services Piping, for materials, products, and installation.

PART 2 PRODUCTS

2.01 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B88, Type L.
- B. DWV Copper Tubing: ASTM B306, Type DWV.
- C. Wrought-Copper Fittings: ASME B16.22.
- D. Wrought-Copper Unions: ASME B16.22.

2.02 JOINING MATERIALS

- A. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.

- B. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

2.03 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated union assembly, for 250-psig minimum working pressure at 180°F.
- D. Dielectric Couplings: Galvanized-steel coupling with inert and non-corrosive thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225°F.

PART 3 EXECUTION

3.01 PIPING APPLICATIONS

- A. Drain Piping: Type DWV or Type L (B), drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

3.02 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated piping locations and arrangements if such were used to size pipe. Install piping as indicated unless deviations to layout are approved on the Coordination Drawings.
- B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise. Avoid routing piping on floor across walkways. Provide steel ramps over piping where floor mounted piping crosses walkways.
- D. Do not install drain piping within electrical rooms, elevator equipment rooms, MDF or IDF rooms, or stairwells. Exception: Pipe serving equipment serving the room. Maintain all required clearances to other equipment.

- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping at a uniform grade of 1.0% downward towards drain outlet unless otherwise indicated.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install cleanouts fabricated with a tee fitting with a threaded plug at each change of direction to facilitate cleaning of pipe. Cleanout shall allow for cleaning in direction of flow.
- J. Install piping to allow application of insulation.
- K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- L. Reduce pipe sizes using concentric reducer fitting or eccentric reducer fitting installed with level side up.
- M. Make branch connections to mains using flow tees.
- N. Unless otherwise indicated, install branch connections to mains with the branch connected to the top or side of the main pipe.
- O. Terminate piping with downturned elbows above an approved indirect receptor or other approved location as indicated on drawings.
- P. Provide an air gap between the pipe termination and receptor or other approved location that is not less than two times the effective diameter or the pipe.
- Q. Install unions in piping, NPS 2 and smaller at final connections of equipment, and elsewhere as indicated.
- R. Identify piping as specified in Specification Section 23 05 53, Identification for HVAC Piping and Equipment.
- S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Specification Section 23 05 17, Sleeves and Sleeve Seals for HVAC Piping.
- T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Specification Section 23 05 17, Sleeves and Sleeve Seals for HVAC Piping.

- U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Specification Section 23 05 18, Escutcheons for HVAC Piping.

3.03 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Specification Section 23 05 29, Hangers and Supports for HVAC Piping and Equipment. Comply with the following requirements for maximum spacing of supports.
- B. Vibration isolation devices are specified in Specification Section 23 05 48.13, Vibration Controls for HVAC Piping and Equipment.
- C. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
 - 2. Wrap copper piping with not less than two layers of 10-mil-thick black plastic tape extending a minimum of 1 inch on each side of clamp for electrolytic protection where hangers or supports are in direct contact with copper piping.
- D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

	Maximum Span	Minimum Rod Size
NPS 3/4	5 feet	1/4 inch

- E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.04 PIPE JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's Copper Tube Handbook, using lead-free solder alloy complying with ASTM B32.

- E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

3.05 TERMINAL EQUIPMENT CONNECTIONS

- A. Install vented traps at cooling coil condensate pan connections. Size trap and connected piping the same as or larger than equipment connections.
- B. Size trap to provide seal against fan static pressure.

3.06 FIELD QUALITY CONTROL

- A. Prepare drain piping according to ASME B31.9 and as follows:
1. Leave joints uninsulated and exposed for examination during test.
 2. Flush drain piping systems with clean water.
 3. Isolate equipment from piping.
- B. Perform the following tests on drain piping:
1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 2. Subject piping system to hydrostatic test pressure that is equal to 10 feet of water column or maximum that can be obtained based on installed conditions.
 3. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
 4. Prepare written report of testing.

END OF SECTION

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SECTION 23 23 00

REFRIGERANT PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes refrigerant piping used for air-conditioning applications.
- B. Refrigerant type shall be consistent with refrigeration equipment specified in other sections.
- C. Refrigerant piping indicated on the drawings is schematic and intended to show the routing of the piping only.

1.02 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-22:
 - 1. Suction Lines for Air-Conditioning Applications: 185 psig.
 - 2. Suction Lines for Heat-Pump Applications: 325 psig.
 - 3. Hot-Gas and Liquid Lines: 325 psig.
- B. Line Test Pressure for Refrigerant R-407c:
 - 1. Suction Lines for Air-Conditioning Applications: 185 psig.
 - 2. Suction Lines for Heat-Pump Applications: 325 psig.
 - 3. Hot-Gas and Liquid Lines: 325 psig.
- C. Line Test Pressure for Refrigerant R-410a:
 - 1. Suction Lines for Air-Conditioning Applications: 300 psig.
 - 2. Suction Lines for Heat-Pump Applications: 525 psig.
 - 3. Hot-Gas and Liquid Lines: 525 psig.

1.03 SUBMITTALS

- A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop based on manufacturer's test data for thermostatic expansion valves, solenoid valves, and pressure-regulating valves.
- B. Pipe Sizing Guidelines: Equipment manufacturer's guidelines for layout and sizing of refrigerant piping.

- C. Shop Drawings: The Contractor is required to submit an isometric piping layout with each condensing unit submittal showing the detailed refrigerant piping layout. This refrigerant pipe layout is to include the following:
 - 1. System identification.
 - 2. All components, accessories, specialties, lengths, and elevation difference between compressor and evaporator.
 - 3. Total equivalent length of the piping system.
 - 4. Pipe sizing, oil traps, double risers, etc., required to ensure proper operation and compliance with warranties of the connected equipment.
 - 5. Refrigerant pipe layout, sizing and components must conform to standard engineering practice as recognized by ARI, the ASHRAE Refrigeration Handbook and the equipment manufacturer's written recommendations.
- D. Field quality-control test reports.
- E. Operation and maintenance data.

1.04 QUALITY ASSURANCE

- A. Comply with ASHRAE 15, Safety Code for Refrigeration Systems.
- B. Comply with ASME B31.5, Refrigeration Piping and Heat Transfer Components.

1.05 PRODUCT STORAGE AND HANDLING

- A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 PRODUCTS

2.01 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B88, Type K or L or ASTM B280, Type ACR.
- B. Wrought-Copper Fittings: ASME B16.22.
 - 1. Elbows shall be long radius type.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Brazing Filler Metals:
 - 1. Copper-to-Copper Joints: BCuP-5 or BCuP-6 without flux.
 - 2. Copper-to-Steel or Brass Joints: BAg-28 with non-acid flux.
- E. Flexible Connectors:
 - 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.

2. End Connections: Socket ends.
 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
 4. Pressure Rating: Factory test at minimum 500 psig.
 5. Maximum Operating Temperature: 250°F.
- F. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends furnished and for use with unitary equipment.

2.02 VALVES

- A. Diaphragm Packless Valves:
1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
 2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
 3. Operator: Rising stem and hand wheel.
 4. Seat: Nylon.
 5. End Connections: Socket, union, or flanged.
 6. Working Pressure Rating: 500 psig.
 7. Maximum Operating Temperature: 275°F.
- B. Packed-Angle Valves:
1. Body and Bonnet: Forged brass or cast bronze.
 2. Packing: Molded stem, back-seating, and replaceable under pressure.
 3. Operator: Rising stem.
 4. Seat: Non-rotating, self-aligning polytetrafluoroethylene.
 5. Seal Cap: Forged-brass or valox hex cap.
 6. End Connections: Socket, union, threaded, or flanged.
 7. Working Pressure Rating: 500 psig.
 8. Maximum Operating Temperature: 275°F.
- C. Packed Ball Valves:
1. Body: Two-piece, forged brass.
 2. Extensions: Copper tubing.
 3. Bonnet: Brass.
 4. Stem Seals: Neoprene.
 5. Ball: Chrome-plated brass.
 6. Seals: Teflon.
 7. Working Pressure Rating: 500 psig.
 8. Maximum Operating Temperature: 300°F.

- D. Service Valves:
 - 1. Body: Forged brass with brass cap including key end to remove core.
 - 2. Core: Removable ball-type check valve with stainless-steel spring.
 - 3. Seat: Polytetrafluoroethylene.
 - 4. End Connections: Copper spring.
 - 5. Working Pressure Rating: 500 psig.
- E. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by a nationally recognized testing laboratory (NRTL).
 - 1. Body and Bonnet: Plated steel.
 - 2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
 - 3. Seat: Polytetrafluoroethylene.
 - 4. End Connections: Threaded.
 - 5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24 VAC coil.
 - 6. Working Pressure Rating: 400 psig.
 - 7. Maximum Operating Temperature: 240°F.

2.03 REFRIGERANT PIPING SPECIALTIES

- A. Moisture/Liquid Indicators:
 - 1. Body: Forged brass.
 - 2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
 - 3. Indicator: Color-coded to show moisture content in ppm.
 - 4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
 - 5. End Connections: Socket or flare.
 - 6. Working Pressure Rating: 500 psig.
 - 7. Maximum Operating Temperature: 240°F.
- B. Replaceable-Core Filter Dryers: Comply with ARI 730.
 - 1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
 - 2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
 - 3. Desiccant Media: Activated alumina or charcoal.
 - 4. Designed for reverse flow (for heat-pump applications).
 - 5. End Connections: Socket.
 - 6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
 - 7. Maximum Pressure Loss: 2 psig.
 - 8. Working Pressure Rating: 500 psig.
 - 9. Maximum Operating Temperature: 240°F.

- C. Permanent Filter Dryers: Comply with ARI 730.
 - 1. Body and Cover: Painted-steel shell.
 - 2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
 - 3. Desiccant Media: Activated alumina or charcoal.
 - 4. Designed for reverse flow (for heat-pump applications).
 - 5. End Connections: Socket.
 - 6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
 - 7. Maximum Pressure Loss: 2 psig.
 - 8. Working Pressure Rating: 500 psig.
 - 9. Maximum Operating Temperature: 240°F.

2.04 ACCUMULATORS

- A. Liquid Accumulators 6-Inch Diameter and Smaller: Comply with ARI 495; listed and labeled by an NRTL.
 - 1. Body: Brazed steel with corrosion-resistant coating.
 - 2. Connections: Socket or threaded for inlet, outlet and pressure relief valve.
 - 3. Working Pressure Rating: 400 psig.
 - 4. Maximum Operating Temperature: 275°F.

2.05 HANGERS AND SUPPORTS

- A. Pipe and Tubing Isolation Devices:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. B-Line Systems.
 - b. Elgen.
 - c. Grinnell.
 - d. Hydra-Zorb.
 - e. Kin-Line.
 - f. Michigan Hanger Co.
 - g. National Pipe Hanger Corp.
 - h. PHD Manufacturing.
 - i. PHS Industries.
 - j. Pipe Technology and Products.
 - k. Unistrut.
 - 2. Material: Oil, fuel, solvent, resistant thermoplastic elastomer. UL Listed for installation in return air plenums with a flame spread rating of 25 or less and a smoke development rating of 50 or less.
 - 3. Design: Slit insert, designed for use with strut clamps to prevent metal-to-metal contact, reduce vibration transmission, and to securely hold pipe or tubing in position.

PART 3 EXECUTION

3.01 PIPING APPLICATIONS

- A. Aboveground Refrigerant Lines:
 - 1. NPS 1-1/2 and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints or refrigerant line kits.
 - 2. NPS 4: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.
- B. Belowground Refrigerant Piping: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints. No joints below ground.
- C. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, K, or L (B) drawn-temper tubing and wrought-copper fittings with soldered joints.

3.02 VALVE AND SPECIALTY APPLICATIONS

- A. Except as otherwise indicated, install diaphragm packless, packed-angle, or packed ball valves on inlet and outlet side of filter dryers.
- B. Install thermostatic expansion valves as close as possible to distributors on evaporators.
 - 1. Install valve so diaphragm case is warmer than bulb.
 - 2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
 - 3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- C. Install safety relief valves where required by the ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
- D. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
- E. Install filter dryers in liquid line between compressor and thermostatic expansion valve.

3.03 PIPING INSTALLATION

- A. Drawing plans indicate general location and arrangement of piping systems. Install piping as indicated on the approved shop drawings.
- B. Install refrigerant piping according to ASHRAE 15.

- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 specifications if valves or equipment requiring maintenance are concealed behind finished surfaces.
- L. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- M. Slope refrigerant piping as follows:
 - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
 - 2. Install horizontal suction lines with a uniform slope downward to compressor.
 - 3. Install traps and double risers to entrain oil in vertical runs.
 - 4. Liquid lines may be installed level.
- N. When brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- O. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

- P. Install sleeves for piping penetrations of walls, ceilings, and floors.
- Q. Install sleeve seals for piping penetrations of concrete walls and slabs.
- R. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.04 PIPE JOINT CONSTRUCTION

- A. Brazed Joints: Construct joints according to AWS Brazing Handbook, Chapter 35, Pipe and Tubing.
 - 1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
 - 2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.
- B. Flow nitrogen or carbon dioxide through pipe and fittings during brazing to prevent scale formation.

3.05 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor products are specified in Specification Section 23 05 29, Hangers and Supports for HVAC Piping and Equipment.
- B. Install the following pipe attachments:
 - 1. Provide trapeze hangers for multiple, parallel runs.
 - 2. Secure pipe to strut supports with pipe clamps or single-piece pipe straps
 - 3. Provide pipe and tube isolation device at each clamp and support.
- C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:

	Maximum Span	Minimum Rod Size
NPS 1/2	60 inches	1/4 inch
NPS 5/8	60 inches	1/4 inch
NPS 1	72 inches	1/4 inch
NPS 1-1/4	96 inches	3/8 inch
NPS 1-1/2	96 inches	3/8 inch
NPS 2	96 inches	3/8 inch
NPS 2-1/2	108 inches	3/8 inch
NPS 3	10 feet	3/8 inch
NPS 4	10 feet	1/2 inch

- D. Support multi-floor vertical runs at least at each floor.

3.06 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. Comply with ASME B31.5, Chapter VI.
 - 2. Test refrigerant piping and specialties. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
 - 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1, Performance Requirements article or as required by the Authorities Having Jurisdiction.
 - a. Fill system with nitrogen to the required test pressure.
 - b. System shall maintain test pressure at the manifold gage throughout duration of test.
 - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
 - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.07 SYSTEM CHARGING

- A. Charge system using the following procedures:
 - 1. Install core in filter dryers after leak test but before evacuation.
 - 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
 - 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
 - 4. Charge system with a new filter-dryer core in charging line.

3.08 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust setpoint temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
 - 1. Open shutoff valves in condenser water circuit.
 - 2. Verify that compressor oil level is correct.
 - 3. Open compressor suction and discharge valves.

4. Open refrigerant valves except bypass valves that are used for other purposes.
 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

SECTION 23 31 13

METAL DUCTS

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes:
 - 1. Rectangular rigid ducts and fittings.
 - 2. Round rigid ducts and fittings.
 - 3. Sheet metal materials.
 - 4. Duct liner.
 - 5. Sealants and gaskets.
 - 6. Hangers and supports.

1.02 PERFORMANCE REQUIREMENTS

- A. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Provide the following for each duct application and pressure classification: Metal gauge, construction methods, reinforcement details and spacing, hangers and support details, seam and joint types. Include manufacturer, description of material, locations for use, R-value, and thickness for duct liner.
- C. Welding certificates.

1.04 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, Structural Welding Code - Steel, for hangers and supports.
 - 2. AWS D9.1M/D9.1, Sheet Metal Welding Code, for duct joint and seam welding.

PART 2 PRODUCTS

2.01 RECTANGULAR RIGID DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, based on indicated static-pressure class unless otherwise indicated.
- B. Duct sizes shown on the drawings are clear, inside dimensions. Adjust sizes of sheet metal ductwork to account for duct lining.
- C. Transverse Joints: Fabricate according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, Figure 2-1, Transverse (Girth) Joints, or manufacturer's instructions for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition. Select joint types from the following:
 - 1. Flat Drive Slip, T-1, T-3.
 - 2. Standing Drive Slip, T-2.
 - 3. Companion, Angle-Van Stone Type, T-22, T-22 Alternate.
 - 4. Flanged, formed, T-24, T-24 Alternate, or one of the following manufactured products:
 - a. Ductmate or WDCI by Ductmate Industries, Inc.
 - b. Elgen- or J-Flange by Elgen Manufacturing.
 - c. FLG J or H by Ward Industries; a Division of Hart & Cooley, Inc.
 - d. J Flange by CL Ward & Family, Inc.
 - e. J Flange by Nexus PDQ; Division of Shilco Holdings Inc.
- D. Longitudinal Seams: Fabricate according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, Figure 2-2, Longitudinal Seams - Rectangular Ducts, for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition. Select seam type based on the following:
 - 1. Duct with Static Pressure 2-Inch wg and Less: Pittsburgh lock hammered flat, L-1, or button punch snap lock, L-2. Do not use button punch snap lock on aluminum duct.
 - 2. Duct with Static Pressure Greater than 2-Inch wg: Pittsburgh lock hammered flat, L-1.
- E. Elbows: Fabricate according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, Figure 4-2, Rectangular Elbows. Comply with requirements for indicated static-pressure class, sealing requirements, support intervals, and other provisions in SMACNA's HVAC

Duct Construction Standards - Metal and Flexible, 3rd Edition. Select elbows from the following types:

1. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3. Mitered Type RE 2 with single thickness turning vanes complying with SMACNA's HVAC Duct Construction Standards - Metal and Flexible, Figure 4-3, Vanes and Vane Runners, and Figure 4-4, Vane Support in Elbows.

- F. Branches: Fabricate according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, Figure 4-5, Divided Flow Branches and Figure 4-6, Branch Connections. Comply with requirements for indicated static-pressure class, sealing requirements, support intervals, and other provisions in SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition. Select branch connections from the following types:
1. Rectangular Main to Rectangular Branch: 45-degree entry.
 2. Rectangular Main to Round Branch: Conical or 45-degree lead in.
- G. Transitions, Offsets, and Other Duct Construction: Select types and fabricate according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, Chapter 4, Fittings and Other Construction, for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition.

2.02 ROUND RIGID DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible, Chapter 3, Round, Oval, and Flexible Duct, based on indicated static-pressure class unless otherwise indicated.
- B. Duct sizes shown on the drawings are clear, inside dimensions. Adjust sizes of sheet metal ductwork to account for duct lining.
- C. Transverse Joints: Select joint types and fabricate according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, Figure 3-1, Transverse Joints - Round Duct, for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition.
1. Transverse Joints in Ducts Larger than 60 Inches in Diameter: Flanged or the following manufactured products:
 - a. SpiralFlange by CL Ward & Family, Inc.

- D. Spiral Seams: Provide spiral seam ductwork using seam RL-1 and fabricate according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible, Figure 3-2, Round Duct Longitudinal Seams, for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition.
 - 1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
- E. Elbows: Fabricate according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, Figure 3-4, Round Duct Elbows. Comply with requirements for indicated static-pressure class, sealing requirements, support intervals, and other provisions in SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition.
 - 1. Minimum Radius-to-Diameter Ratio shall be 1.5.
 - 2. Elbow Segments: Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, Table 3-1, Mitered Elbows. Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - 3. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 - 4. Round Elbows, 14 Inches and Larger in Diameter: Welded.
- F. Tees and Laterals: Fabricate according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, Figure 3-5, 90 Degree Tees and Laterals, and Figure 3-6, Conical Tees. Comply with requirements for indicated static-pressure class, sealing requirements, support intervals, and other provisions in SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition. Select tees and laterals based on the following:
 - 1. Velocity up to 1,500 fpm: Conical tap.
 - 2. Velocity 1,500 fpm or Higher: 45-degree lateral.
 - 3. Conical saddle taps may be used in existing duct.

2.03 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.

- C. Stainless-Steel Sheets: Comply with ASTM A480/A480M, Type 304 or 316, as indicated in the Duct Schedule article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the Duct Schedule article.
- D. Aluminum Sheets: Comply with ASTM B209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- E. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.
 - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- F. Tie Rods: Galvanized steel, stainless steel, or aluminum to match duct material, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.04 DUCT LINER

- A. Fibrous-Glass Duct Liner: Comply with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, Fibrous Glass Duct Liner Standard.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation; Insulation Group.
 - b. Johns Manville.
 - c. Knauf Insulation.
 - d. Owens Corning.
 - 2. Maximum Thermal Conductivity: Type I, Flexible: 0.27 Btu x in./h x sq. ft. x degrees F at 75°F mean temperature.
 - 3. Anti-Microbial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture-repellent and erosion-resistant coating. Anti-microbial compound shall be tested for efficacy by a nationally recognized testing laboratory (NRTL) and registered by the EPA for use in HVAC systems.
 - 4. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C916.
 - a. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Mechanical Fasteners:
 - 1. Metal, Capacitor-Discharge-Weld Pin, Insulation Hangers: Copper-coated, low carbon steel, or stainless steel, fully annealed,

- 0.106-inch-diameter shank, length to suit depth of insulation indicated.
May be provided with base.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized or stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 3. Metal, Cupped-Head, Capacitor-Discharge-Weld Pins:
 - a. Head: Galvanized, carbon-steel or stainless-steel sheet, minimum of 0.016 inch thick with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - b. Spindle: Copper- or zinc-coated, low carbon steel, or stainless-steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
- C. Shop Application of Fibrous-Glass Duct Liner: Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, Figure 7-11, Flexible Duct Liner Installation.
1. Duct sizes shown on the drawings are clear, inside dimensions. Adjust sizes of sheet metal ductwork to account for duct lining.
 2. Adhere a single layer of indicated thickness of duct liner with at least 90% adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
 3. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
 4. Butt transverse joints without gaps, and coat joint with adhesive.
 5. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
 6. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
 7. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2,500 fpm.
 8. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
 9. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 - a. Fan discharges.
 - b. Intervals of lined duct preceding unlined duct.
 - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2,500 fpm or where indicated.
 10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts

(metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.05 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Polymer Joint and Seam Sealant:
 - 1. Application Method: Pump applied during duct forming or assembly.
 - 2. Solids Content: Minimum 90%.
 - 3. Water resistant.
 - 4. Mold and mildew resistant.
 - 5. Non-skinning, non-drying.
 - 6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 - 7. Service: Indoor or outdoor.
 - 8. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless-steel, or aluminum sheets.
- C. Water-Based Joint and Seam Sealant:
 - 1. Application Method: Brush on.
 - 2. Solids Content: Minimum 65%.
 - 3. Shore A Hardness: Minimum 20.
 - 4. Water resistant.
 - 5. Mold and mildew resistant.
 - 6. VOC: Maximum 75 g/L (less water).
 - 7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 - 8. Service: Indoor or outdoor.
 - 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless-steel, or aluminum sheets.
- D. Flanged Joint Sealant: Comply with ASTM C920.
 - 1. General: Single-component, acid-curing, silicone, elastomeric.
 - 2. Type: S.
 - 3. Grade: NS.
 - 4. Class: 25.
 - 5. Use: O.
 - 6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.06 HANGERS AND SUPPORTS

A. Hanger Rods for Non-Corrosive Environments: Cadmium-plated steel rods and nuts.

B. Strap and Rod Sizes: Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, Table 5-1, Rectangular Duct Hangers Minimum Size, and Table 5-2, Minimum Hanger Sizes for Round Duct.

C. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.

D. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A492.

E. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

G. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 EXECUTION

3.01 DUCT INSTALLATION – GENERAL REQUIREMENTS

- A.** Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved.

- B. Install ducts according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of the same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Specification Section 23 33 00, Air Duct Accessories, for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris, dust, and other foreign materials. Comply with the "Advanced Level" of cleanliness as defined in SMACNA's Duct Cleanliness for New Construction Guidelines.
 - 1. This includes protecting the ductwork from dirt, debris and moisture, during transportation to the jobsite, prior to installation at the jobsite, and after installation.

3.02 DUCT SEALING

- A. Seal ducts to the following seal classes according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible:
 - 1. All Ductwork: Seal Class A.
 - 2. All joints, wall penetrations, and seams to be externally sealed even if internal sealant is applied during duct forming and fabrication, except for exposed ductwork.

3.03 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, Chapter 5, Hangers and Supports.
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured and as directed by the Structural Engineer.
- C. Hanger Spacing: Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, Table 5-1, Rectangular Duct Hangers Minimum Size, and Table 5-2, Minimum Hanger Sizes for Round Duct, for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod, and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.04 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Specification Section 23 33 00, Air Duct Accessories.
- B. Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition and requirements herein for branch, outlet and inlet, and terminal unit connections.

3.05 PAINTING

- A. Paint the inside of any ductwork including manual volume dampers that is visible through a grille, register, or diffuser with one coat of flat, black paint. Visible duct liner must have a black finish.

3.06 STARTUP

- A. Air Balance: Comply with requirements in Specification Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.

3.07 DUCT SCHEDULE

- A. Fabricate rigid ducts with galvanized sheet steel except as otherwise indicated.
- B. Supply Ducts:
 - 1. Ducts Connected to Fan Coil Units, Furnaces, Air-Conditioners, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: Refer to Duct Sealing article.
 - c. SMACNA Leakage Class for Rectangular: 16.
 - d. SMACNA Leakage Class for Round and Flat Oval: 8.
 - 2. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: Refer to Duct Sealing article.
 - c. SMACNA Leakage Class for Rectangular: 16.
 - d. SMACNA Leakage Class for Round and Flat Oval: 8.
- C. Return Ducts:
 - 1. Ducts Connected to Fan Coil Units, Furnaces, Air-Conditioners, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive or negative 1-inch wg.
 - b. Minimum SMACNA Seal Class: Refer to Duct Sealing article.
 - c. SMACNA Leakage Class for Rectangular: 16.
 - d. SMACNA Leakage Class for Round and Flat Oval: 8.
 - 2. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: Refer to Duct Sealing article.
 - c. SMACNA Leakage Class for Rectangular: 16.
 - d. SMACNA Leakage Class for Round and Flat Oval: 8.
- D. Intermediate Reinforcement:
 - 1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.
 - 2. PVC-Coated Ducts:
 - a. Exposed to Airstream: Match duct material.
 - b. Not Exposed to Airstream: Match duct material.
 - 3. Stainless-Steel Ducts:
 - a. Exposed to Airstream: Match duct material.
 - b. Not Exposed to Airstream: Match duct material.
 - 4. Aluminum Ducts: Aluminum.
- E. Duct Liner: Furnish ducts with duct liner for the following applications unless noted otherwise on the drawings:
 - 1. Rectangular Supply and Return Air Ducts Within a Return Air Plenum: Fibrous glass, Type I, 1/2 inch thick with a minimum R-value of 2.

2. Rectangular Supply and Return Air Ducts Within the Building Envelope:
Fibrous glass, Type I, 1-1/2 inches thick with a minimum R-value of 6.
3. Exception: Do not line ductwork connected to evaporative coolers,
ductwork connected to kitchen hoods, outside air intakes, ductwork
serving shower areas, or combustion air ducts.

END OF SECTION

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SECTION 23 33 00

AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes:
 - 1. Manual volume dampers.
 - 2. Fire dampers.
 - 3. Smoke dampers.
 - 4. Combination fire/smoke dampers.
 - 5. Flange connectors.
 - 6. Turning vanes.
 - 7. Flexible ducts.

1.02 SUBMITTALS

- A. Product Data: Provide manufacturer's product data for each duct accessory intended for use on this project. Data to be specific to the items proposed for the project with all options and accessories indicated. Include the following as a minimum:
 - 1. Manufacturer and model number.
 - 2. Dimensions.
 - 3. Electrical data for damper motor operators including voltage and motor ampacity.
 - 4. Materials of construction.
 - 5. Accessories and options.
 - 6. Installation details for fire, smoke, and combination fire/smoke dampers for each application intended for this project.
- B. Test reports for smoke and combination fire/smoke dampers.
- C. Warranty information.
- D. Operation and maintenance data.

1.03 QUALITY ASSURANCE

- A. Comply with NFPA 90A, Installation of Air Conditioning and Ventilating Systems, and with NFPA 90B, Installation of Warm Air Heating and Air Conditioning Systems.
- B. Comply with AMCA 500-D testing for damper rating.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- C. Stainless-Steel Sheets: Comply with ASTM A480/A480M, Type 304, and having a No. 2 finish for concealed ducts and No. 4 finish for exposed ducts.
- D. Aluminum Sheets: Comply with ASTM B209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, one-side bright finish for exposed ducts.
- E. Extruded Aluminum: Comply with ASTM B221, Alloy 6063, Temper T6.
- F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.02 DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Air Balance Inc.
 - 2. Elgen Manufacturing.
 - 3. Greenheck Fan Corporation.
 - 4. McGill Airflow LLC.
 - 5. Metal Form.
 - 6. Nailor Industries Inc.
 - 7. National Controlled Air.
 - 8. Pottorff.
 - 9. Ruskin Company.
 - 10. Safe-Air-Dowco.
 - 11. Vent Products Company, Inc.
 - 12. Young Regulator Company.

B. Manual Volume Dampers:

1. Rectangular:

- a. Factory fabricated for shutoff or balancing duty in branch ducts:
 - 1) Standard leakage rating, with linkage outside airstream.
 - 2) Suitable for horizontal or vertical applications.
 - 3) Frames:
 - a) Hat-shaped, galvanized-steel or aluminum channels.
 - b) Mitered and welded corners.
 - c) Flanges for attaching to walls and flangeless frames for installing in ducts.
 - 4) Blades:
 - a) Multiple with maximum blade width of 8 inches.
 - b) Opposed-blade design.
 - c) Stiffen damper blades for stability.
 - d) Galvanized steel, 0.064 inch thick, or aluminum 0.10 inch thick to match frame.
 - 5) Blade Axles: Galvanized steel or aluminum to match frame and blades.
 - 6) Bearings:
 - a) Oil-impregnated bronze or molded synthetic.
 - b) Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 7) Tie Bars and Brackets: Galvanized steel or aluminum to match frame and blades.
 - 8) Jackshaft:
 - a) Size: 1-inch diameter.
 - b) Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
 - c) Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.
 - 9) Damper Hardware:
 - a) Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
 - b) Include center hole to suit damper operating-rod size.
 - c) Include elevated platform for insulated duct mounting.
- b. Shop and field fabricated for balancing duty in duct runouts serving a single diffuser, grille, or register:
 - 1) Blade: Single blade volume damper constructed per SMACNA Standards.
 - 2) Handle: Stamped or cast metal configured to indicate damper position in duct. Provide extension to raise handle above duct insulation and locking device such as wing nut to secure

extension device to side of damper bearing and duct, or standoff with locking quadrant to secure damper in position, similar to Ventlok 641 in uninsulated ducts, 644 in insulated ducts, or 555 with standoff in either.

2. Round:
 - a. Factory fabricated for shutoff or balancing duty in branch ducts:
 - 1) Standard leakage rating.
 - 2) Suitable for horizontal or vertical applications.
 - 3) Frames: Galvanized-steel channel.
 - 4) Blades: Galvanized steel, minimum 16 gauge.
 - 5) Blade Axles: Plated steel extending minimum 6 inches beyond frame.
 - 6) Bearings: Nylon sleeve with stainless-steel thrust washers.
 - 7) Stops: Plated screw for both open and closed positions.
 - 8) Damper Hardware:
 - a) Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
 - b) Include center hole to suit damper operating-rod size.
 - c) Include elevated platform for insulated duct mounting.
 - d) Include locking quadrant to secure damper in position similar to Ventlok 555 or self-locking handle similar to Ventlok 641 in uninsulated ducts or Ventlok 644 in insulated ducts.
 - b. Shop and field fabricated for balancing duty in duct runouts serving a single diffuser, grille or register:
 - 1) Blade: Single blade volume damper constructed per SMACNA Standards.
 - 2) Stamped or cast metal configured to indicate damper position in duct. Provide extension to raise handle above duct insulation and locking device such as wing nut to secure extension device to side of damper bearing and duct, or standoff with locking quadrant to secure damper in position, similar to Ventlok 641 in uninsulated ducts, 644 in insulated ducts, or 555 with standoff in either.
3. Remote Damper Operators:
 - a. Damper operator for remote operation of manual balancing dampers located above hard ceilings or other inaccessible locations.
 - b. Electrically Activated: Greenheck RBD-10.
 - 1) Electrically actuated motor for field mounting on manual balancing damper shaft.
 - 2) Plenum-rated, interconnect cable in length suitable to reach remote wall, ceiling, or diffuser plate.
 - 3) Handheld, battery-powered controller for actuation of motor.
 - c. Manually Activated: Young 270-315.
 - 1) Galvanized steel rack and pinion controller for attachment to the balancing damper shaft.

- 2) Bowden cable with galvanized steel outer casing and stainless-steel inner wire in length as required but no more than 50 feet.
- 3) Ceiling mounted, die-cast mounting cup, with adjustable threaded cover.
- d. Provide all accessories required for the intended application.

2.03 FIRE DAMPERS, SMOKE DAMPERS, COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Greenheck Fan Corporation.
 2. Pottorff; a Division of PCI Industries, Inc.
 3. Ruskin Company.
- B. Fire Dampers:
 1. Type: Dynamic; rated and labeled according to UL 555 by a nationally recognized testing laboratory (NRTL).
 2. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4,000-fpm velocity.
 3. Fire Rating: 1-1/2 hours or longer as required or noted on the drawings.
 4. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.
 5. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
 - a. Minimum Thickness: 0.052 to 0.138 inch thick and of length to suit application.
 - b. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
 6. Mounting Orientation: Vertical or horizontal as indicated.
 7. Blades: Roll-formed, interlocking, 0.034-inch-thick galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick galvanized-steel blade connectors.
 8. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
 9. Heat-Responsive Device: Replaceable, 165°F rated, fusible links.
- C. Smoke Dampers:
 1. General Requirements: Label according to UL 555S by an NRTL.
 2. Smoke Detector: Integral, factory wired for single-point connection where indicated.
 3. Frame: Multiple-blade type fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

4. Blades: Roll-formed, horizontal, interlocking, 0.034-inch-thick galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick galvanized-steel blade connectors.
 5. Leakage: Class I.
 6. Rated pressure and velocity to exceed design airflow conditions.
 7. Mounting Sleeve: Factory-installed, galvanized sheet steel; length to suit wall or floor application.
 8. Damper Motors: Two-position action, externally mounted.
 9. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Specification Section 23 05 13, Common Motor Requirements for HVAC Equipment.
 - a. Motor Sizes: Provide motor large enough so driven load will not require motor to operate in service factor range above 1.0.
 - b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 sections.
 - c. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 - d. Spring-Return Motors: Equip with an integral spiral-spring mechanism. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf. and breakaway torque rating of 150 in. x lbf.
 - e. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at -40°F.
 - f. Electrical Connection: 115 V, single phase, 60 Hz.
 10. Accessories:
 - a. Auxiliary switches for signaling or position indication where dampers are installed in smoke control systems or elsewhere as indicated.
 - b. Momentary test switch, and test and reset switches, damper or remote mounted as indicated.
- D. Combination Fire and Smoke Dampers:
1. General Requirements: Label according to UL 555 and UL 555S by an NRTL.
 2. Closing rating in ducts up to 4-inch wg static pressure and maximum airflow through the open damper of 2,000 fpm.
 3. Smoke Detector: Integral, factory wired for single-point connection where indicated.
 4. Fire Rating: 1-1/2 hours or longer as required or noted on the drawings.
 5. Leakage: Class 1.

6. Rectangular Damper Construction:
 - a. Frame: Hat-shaped, minimum 0.094-inch-thick galvanized sheet steel, with welded or interlocking, gusseted corners and mounting flange.
 - b. Blades: Horizontal, airfoil shaped, minimum 0.063-inch-thick galvanized sheet steel.
 - c. Mounting Sleeve: Factory-installed, galvanized sheet steel; length to suit wall or floor application.
7. Round Damper Construction:
 - a. Frame/Sleeve: Round, minimum 0.040-inch-thick galvanized sheet steel.
 - b. Blades: Two-piece, 0.080-inch-thick galvanized sheet steel with silicone edge seal.
8. Heat Response Device: Electric fuse link 165°F rated.
9. Damper Motors: Two-position action, externally mounted unless indicated otherwise.
10. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Specification Section 23 05 13, Common Motor Requirements for HVAC Equipment.
 - a. Motor Sizes: Provide motor large enough so driven load will not require motor to operate in service factor range above 1.0.
 - b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 sections.
 - c. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 - d. Spring-Return Motors: Equip with an integral spiral-spring mechanism. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf. and breakaway torque rating of 150 in. x lbf.
 - e. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at -40°F.
 - f. Electrical Connection: 115 V, single phase, 60 Hz.
11. Accessories:
 - a. Auxiliary switches for signaling or position indication where dampers are installed in smoke control systems or elsewhere as indicated.
 - b. Momentary test switch, and test and reset switches, damper or remote mounted as indicated.

2.04 TURNING VANES

- A. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades; set into vane runners suitable for duct mounting.
- B. General Requirements: Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition; Figures 4-3, Vanes and Vane Runners, and 4-4, Vane Support in Elbows.
- C. Vane Construction: Single thickness with 3/4-inch trailing edge spaced at 1-1/2-inch centers.

2.05 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Atco Flex.
 - 2. Elgen.
 - 3. Flexmaster U.S.A., Inc.
 - 4. Genflex.
 - 5. Manville.
 - 6. Owens-Corning.
 - 7. Therma Flex.
 - 8. Wiremold.
- B. Insulated, Flexible Duct: UL 181, Class 1, polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.
 - 1. Pressure Rating:
 - a. Low Pressure: 4-inch wg positive and 0.5-inch wg negative.
 - 2. Maximum Air Velocity: 4,000 fpm.
 - 3. Temperature Range: -20 to +175°F.
 - 4. Insulation R-Value: Comply with the latest edition of ASHRAE/IESNA 90.1.
- C. Flexible Duct Connectors:
 - 1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Select duct accessories suitable for the pressure class of the ductwork to which it is attached.
- B. Install duct accessories according to applicable details in SMACNA's HVAC Duct Construction Standards - Metal and Flexible for metal ducts.
- C. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- D. Install turning vanes in all rectangular duct elbows having a 45-degree or greater bend as indicated.
- E. Install volume dampers at points on supply, return, and exhaust systems where branches serving diffusers and grilles extend from larger ducts. Install dampers where accessible and as close to mains as possible. Where dampers are installed in ducts having duct liner, install dampers with hat channels of the same depth as liner, and terminate liner with nosing at hat channel.
 - 1. Install steel volume dampers in steel ducts.
 - 2. Install aluminum volume dampers in aluminum ducts.
- F. Install volume dampers in outside-air systems at the connection to the equipment served.
 - 1. Install steel volume dampers in steel ducts.
 - 2. Install aluminum volume dampers in aluminum ducts.
- G. Install volume dampers where directed by the Test and Balance Contractor as required for proper system balancing.
- H. Remote Damper Operators:
 - 1. Install remote damper operators for all dampers located above hard ceilings or for dampers that will otherwise be inaccessible at the completion of construction.
 - 2. Install remote damper operator in accordance with the manufacturer's written instructions.
 - 3. Locate operator interface as indicated on the drawings or as instructed by the Engineer.
 - 4. Finish cover to match adjacent ceiling.
- I. Set dampers to fully open position before testing, adjusting, and balancing.

- J. Install fire and smoke dampers according to UL listing at all duct penetrations of rated assemblies as required to maintain the rating as designated on the drawings.
- K. Mount duct smoke detectors in strict conformance with manufacturer's recommendations. Duct smoke detectors to be furnished and wired as specified in Division 21, 26 or 28.
- L. Flexible duct may only be used in the following locations with the following limitations:
 - 1. Connect diffusers, grilles, or registers located in lay-in ceilings to ducts with maximum 60 inch lengths of low-pressure flexible duct secured in place with stainless-steel clamps.
 - 2. Install flexible ducts stretched and supported without kinks or sags.

3.02 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Operate dampers to verify full range of movement.
 - 2. Inspect locations of access doors and verify that purpose of access door can be performed.
 - 3. Operate fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
 - 4. Inspect turning vanes for proper and secure installation.

END OF SECTION

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SECTION 23 81 26

SPLIT-SYSTEM AIR CONDITIONERS

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.02 SUBMITTALS

- A. Product Data: Provide manufacturer's product data for each unit indicated on the drawings. Data to be specific to the equipment proposed for the project with all options and accessories indicated. Include the following as a minimum:
 - 1. Manufacturer and model number.
 - 2. Rated capacity based on scheduled conditions and project elevation.
 - 3. Equipment dimensions and weights.
 - 4. Required clearances.
 - 5. Electrical Data:
 - a. Motor horsepower.
 - b. Voltage/Phase/Hz.
 - c. Full load ampacity, minimum circuit ampacity and maximum overcurrent protection device requirements.
 - d. Electrical service point(s) of connection.
 - e. AIC rating of the equipment.
 - 6. Materials of construction.
 - 7. Accessories and options.
 - 8. Controls.
- B. Warranty information.
- C. Operation and maintenance data.

1.03 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
 - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, Safety Standard for Refrigeration Systems.

2. Applicable requirements in the latest edition of ASHRAE 62.1, Section 4 - Outdoor Air Quality, Section 5 - Systems and Equipment, Section 6 - Procedures, and Section 7 - Construction and System Start-Up.

- C. ASHRAE/IESNA Compliance: Applicable requirements in the latest edition of ASHRAE/IESNA 90.1.

1.04 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
 1. Warranty Period:
 - a. For Compressor: 5 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on the drawings or comparable product by one of the following:
 1. Ductless Units:
 - a. Carrier Corporation.
 - b. Daikin.
 - c. Fujitsu General America, Inc.
 - d. LG Electronics.
 - e. Mitsubishi.
 - f. Panasonic Corporation.

2.02 DUCTLESS INDOOR UNITS

- A. Recessed Ceiling-Fan Components:
 1. Cabinet: Zinc-coated steel with hinged grilles to provide access.
 2. Insulation: Faced, glass-fiber duct liner.
 3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.
 4. Fan: Direct drive, centrifugal.
 5. Fan Motors: Open drip-proof, permanently lubricated ball bearing, multi-speed with overload protection.
 6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in the latest edition of ASHRAE 62.1.
 7. Filters: Provide filter rack with factory-supplied cleanable filters.

8. Condensate Drain Pans:
 - a. Fabricated with slope to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and direct water toward drain connection.
 - b. Provide condensate pump with overflow switch to shut off the unit in case of pump malfunction.
 9. Air Discharge: Adjustable louvers discharging air at the unit perimeter, user selectable air sweep, 2-, 3-, or 4-way pattern.
- B. Wall-Mounted and Ceiling-Suspended Evaporator-Fan Components:
1. Cabinet: Zinc-coated steel chassis with removable, white, enameled steel or plastic panels on front and ends, with rear outside air intake.
 2. Insulation: Faced, fiberglass duct liner.
 3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.
 4. Fan: Direct drive, centrifugal.
 5. Fan Motors: Open drip-proof, permanently lubricated ball bearing, multi-speed with overload protection.
 6. Disconnect: Provide unit-mounted disconnect switches (unless power is supplied from the outdoor unit).
 7. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in the latest edition of ASHRAE 62.1.
 8. Filters: Provide filter rack with factory-supplied cleanable filter.
 9. Condensate Drain Pans:
 - a. Fabricated with slope to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and direct water toward drain connection.
 - b. Provide condensate pump with overflow switch to shut off the unit in case of pump malfunction.
 10. Air Discharge: Front discharge with horizontal air sweep.

2.03 DUCTED INDOOR UNITS (5 TONS OR LESS)

- A. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
- B. Insulation: Faced, glass-fiber duct liner.
- C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.
- D. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.

- E. Fan Motors:
 - 1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Specification Section 23 05 13, Common Motor Requirements for HVAC Equipment.
 - 2. Multi-tapped, multi-speed with internal thermal protection and permanent lubrication.
 - 3. Wiring Terminations: Connect motor to chassis wiring with plug connection.
- F. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- G. Filters: Comply with NFPA 90A.
 - 1. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
 - 2. Provide filter holding frame for 1-inch-thick filter, arranged for flat orientation, with access door on side of unit.
 - 3. Comply with requirements of Division 23 sections.
 - 4. Provide filters as indicated on the drawings.
- H. Condensate Drain Pans:
 - 1. Fabricated with minimum 1% slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and to direct water toward drain connection.
 - a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
 - b. Depth: A minimum of 1 inch deep.
 - 2. Single-wall, stainless-steel sheet or plastic.
 - 3. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
 - 4. Overflow Switch: Provide condensate overflow switch wired to shut off unit in case of condensate drain malfunction.

2.04 OUTDOOR UNITS (5 TONS OR LESS)

- A. Description: Factory assembled and tested, air cooled; consisting of casing, compressors, condenser coils, condenser fans and motors, and unit controls. Controls shall permit operation in cooling mode down to 25°F and heat pump operation down to 15°F.
- B. Casing: Steel, finished with baked enamel with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

- C. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - 1. Compressor Type: Scroll or variable-speed scroll as indicated.
 - 2. Refrigerant Charge: R-407c or R-410A as scheduled.
 - 3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid sub-cooler. Comply with ARI 210/240.
- D. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
- E. Condenser Coil: Seamless copper-tube, aluminum-fin coil, including sub-cooling circuit and backseating liquid-line service access valve. Factory pressure test coils, then dehydrate by drawing a vacuum and fill with a holding charge of nitrogen or refrigerant.
- F. Fan: Aluminum propeller type, statically and dynamically balanced directly connected to motor.
- G. Motor: Totally enclosed permanently lubricated, with integral thermal-overload protection.

2.05 ACCESSORIES

- A. Thermostat: Low-voltage, wall-mounted, 7-day programmable type to control compressor and evaporator fan, with the following features:
 - 1. Compressor time delay.
 - 2. 24-hour time control of system stop and start.
 - 3. Liquid-crystal display indicating temperature, setpoint temperature, time setting, operating mode, and fan speed.
 - 4. Fan-speed selection including auto setting.
- B. Automatic-reset timer to prevent rapid cycling of compressor.
- C. Condenser coil hail guards to protect coil from damage.
- D. Field-Installed Hot-Gas Bypass Where Scheduled: Consisting of Rawall APR control valve installed to bypass hot refrigerant gas around the compressor. Install on first stage of cooling on units with multiple refrigerant circuits. Provide manual isolation valve on each side of APR.
- E. Low Ambient Kit: Permits operation down to 10°F where scheduled.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install ground-mounted, compressor-condenser components on 4-inch-thick, reinforced concrete base that is 4 inches larger, on each side, than unit. Concrete, reinforcement, and formwork are specified in Division 03 specifications. Coordinate anchor installation with concrete base.
- D. Install roof-mounted, compressor-condenser components on equipment supports installed in accordance with Division 07 specifications. Anchor units to supports with removable, cadmium-plated fasteners.

3.02 CONNECTIONS

- A. Install and connect refrigerant piping in accordance with Specification Section 23 23 00, Refrigerant Piping, to component's quick-connect fittings. Install piping to allow access to unit.
- B. Condensate Drainage Connections: Comply with applicable requirements in Specification Section 23 21 15, HVAC Drain Piping.
- C. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

3.03 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.

3.04 DEMONSTRATION

- A. Train the Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION

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DIVISION 26

ELECTRICAL

- 26 05 00 Common Work Results for Electrical**
 - 26 05 00 General Provisions
 - 26 05 02 Temporary & Remodeling Work
 - 26 05 19 Low-Voltage Electrical Power Conductors & Cables
 - 26 05 26 Grounding & Bonding of Electrical Equipment
 - 26 05 33 Raceway & Boxes for Electrical Systems
- 26 27 00 Low-Voltage Distribution Equipment**
 - 26 27 26 Wiring Devices
- 26 28 00 Low-Voltage Circuit Protective Devices**
 - 26 28 13 Overcurrent Protection
 - 26 28 16 Enclosed Switches & Circuit Breakers
- 26 51 00 Interior Lighting**
 - 26 51 00 Interior Lighting Fixtures & Lamps

END OF INDEX





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SECTION 26 05 00

GENERAL PROVISIONS

PART 1 GENERAL

1.01 SCOPE

- A. Provisions of this section apply to all work specified in all sections under Division 26.
- B. In addition, work in Division 26 is governed by the provisions of the Bidding Requirements, Contract Forms, General Conditions, and all sections in Division 01 specifications.
- C. The drawings and specifications do not specify exact installation means and methods or Contractor safety procedures. Installation means and methods and safety procedures are, and shall remain, the responsibility of the Contractor. No instruction or statement made on the drawings, specifications, future addenda, or change orders shall be interpreted to shift this responsibility away from the Contractor.
- D. These specifications contain statements which are more definitive or more restrictive than those contained in the General Conditions. Where these statements occur, they shall take precedence over the General Conditions. Where the word “provide” or “provision” is used, it shall be definitely interpreted as “furnishing and installing complete in operating condition.” Where the words “as indicated” or “as shown” are used, they shall mean “as shown on the Contract Drawings.” Where items are specified in the singular, this division shall provide the quantity as shown on the drawings, plus any spares or extras mentioned on the drawings or in the specifications. All specified and supplied equipment shall be new.

1.02 DEFINITIONS

- A. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include tunnels, trenches, hollow perimeter construction, above exterior furred spaces, and exterior suspended ceilings.
- B. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings, in duct shafts, and within hollow construction.

- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations, under canopies, and equipment yards.
- D. Exposed, Interior Installations: Exposed to view indoors. Examples include unfinished spaces, mechanical, electrical, and communication equipment rooms, and other areas solely for maintenance and repair.
- E. Exposed: Not concealed.
- F. Finished Space: A space other than mechanical, electrical, and communication equipment rooms, crawlspaces, and utility tunnels. Not an unfinished space.
- G. Unfinished Space: A room or space that is ordinarily accessible only to building maintenance personnel. A room noted on the “Finish Schedule” with exposed and unpainted construction for walls, floors, or ceilings, or specifically mentioned as “unfinished.”

1.03 EXAMINATION OF PREMISES

- A. Visit the site, verify all measurements and project conditions, and pay all costs necessary to perform the work.

1.04 ELECTRICAL CONTRACTOR

- A. The Electrical Contractor shall be licensed as such in the state governing the project location. This license shall remain valid for the duration of the contract and shall have been valid for a minimum of 2 years prior to the contract award date.

1.05 REGULATIONS, PERMITS, FEES, CHARGES, INSPECTIONS

- A. Regulations: Comply with all applicable codes, rules and regulations.
- B. Fees and Permits: Pay all connection, installation, use, development, etc., fees and/or charges. Obtain and pay for all required permits and licenses. Refer to Division 01 specifications.
- C. Inspections: All work must be inspected and approved by local authorities. Prior to final approval, furnish the Engineer with certificates of inspections and approvals by the local authorities in accordance with Division 01 specifications.

1.06 DRAWINGS AND SPECIFICATIONS

- A. If a conflict exists on the drawings or between the drawings and specifications, promptly notify the Engineer.

1.07 SUBMITTALS

- A. Submittals are for information and coordination only. The Engineer will diligently review the submittals and attempt to verify compliance with the project requirements. Such review, however, does not constitute approval or disapproval of obligation to comply with all project requirements. The submittals are not to be construed to be contract documents. Any failure by the Engineer to note a point of non-compliance shall not be construed to be acceptance or approval of the discrepancy.
- B. Product Information Sheets: Provide manufacturer's literature which includes the information required by the Product Data paragraph of the applicable specification section. Where product information sheets show multiple models or options, clearly mark the model and options to be provided.
- C. Assembly: Assemble all required submittal information for each specification section and submit in PDF format.
 - 1. Assemble PDF submittals in one PDF file for each division. Separate and order sections within each file by corresponding specification number. Provide bookmarks at the first page of each section and label each bookmark with the specification number and name to allow for easy navigation of the submittal.
 - 2. Partial submittals will be returned without review. Partial submittals and submittals that are not project specific will be returned without review.
- D. Identification and Information:
 - 1. Name the PDF file with the project name, division number, and sequential submittal number (i.e., the first submittal shall be No. 1; the second submittal shall be No. 2).
 - 2. Provide a cover sheet at the front of each submittal with the following information:
 - a. Project name.
 - b. Date.
 - c. Name of Engineer.
 - d. Name of Contractor.
 - e. Name of subcontractor.
 - 3. Provide a cover sheet at the front of each submittal section with the following information:
 - a. Name of supplier.
 - b. Name of manufacturer.

- c. Number and title of appropriate specification section.
 - d. Drawing number and detail references, as appropriate.
 - e. Other necessary identification.
- E. Options:
 - 1. Identify options requiring selection by the Engineer.
 - 2. Identify options included with submittal item.
- F. Deviations: Identify deviations in a line-by-line comparison format to the Contract Documents and include as a cover sheet to the product submittal. Include statement(s) and documentation supporting the acceptability of the deviation.
- G. Furnished by Others: This project is to provide a complete and functional system. Where material or labor is indicated in the submittal to be provided “by others,” clearly indicated who is providing those items and include information to indicate proper coordination.

1.08 MATERIAL SAFETY DATA SHEETS

- A. Provide current Material Safety Data Sheets (MSDS) for all hazardous chemicals that are proposed for use at the project site.
 - 1. Provide one complete set to the Owner for review and approval a minimum of 1 week prior to the delivery of any hazardous chemicals to the site.
 - 2. Maintain a second complete set at the project location, readily accessible by both the Owner’s personnel and the Contractor’s personnel.

1.09 REQUEST FOR INFORMATION

- A. A document submitted by the Contractor requesting clarification of a portion of the Contract Documents, hereinafter referred to as an RFI.
- B. A properly prepared RFI shall include a detailed written statement of the clarification, apparent conflict, or information requested that indicates the specific drawings or specifications in need of clarification and the nature of the clarification requested.
 - 1. Drawings shall be identified by drawing number and location on the drawing sheet.
 - 2. Specifications shall be identified by section number, page, and paragraph.
- C. Include a proposed solution, where appropriate, based on the field conditions and best knowledge of the Contractor.

1.10 AS-BUILT DRAWINGS

- A. As-Built Drawings: Maintain one set of marked-up digital or paper copies of the Contract Drawings.
 - 1. Preparation: Mark the As-Built Drawings to show the actual installation where installation varies from that shown originally. Include underground and overhead conduit.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Include dimensions both horizontally and vertically to permanent points of reference, accurate within 6 inches. Include descriptors such as “below slab,” “above ceiling,” etc.
 - c. Record data daily or as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
 - 2. Mark the As-Built Drawings completely and accurately. Utilize personnel proficient at recording graphic information in production of the As-Built Drawings.
 - 3. Mark the As-Built Drawings with erasable, red-colored pencil, or in a digital PDF format using an editor program such as Bluebeam, Adobe Acrobat Professional, or similar. Use other colors to distinguish between changes for different categories of the work at the same location.
 - 4. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
 - 5. Update the As-Built Drawings weekly or daily as appropriate for the project size.
- B. Format: Identify and date each As-Built Drawing; include the designation “PROJECT AS-BUILT DRAWING” in a prominent location.
 - 1. Organize newly prepared As-Built Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 - 2. Identify the As-Built Drawings as follows:
 - a. Project name.
 - b. Date.
 - c. Designation “PROJECT AS-BUILT DRAWINGS.”
 - d. Name of Engineer.
 - e. Name of Contractor.
 - 3. Remove or obscure the Engineer’s seal and signature from the As-Built drawings.

1.11 OPERATION AND MAINTENANCE MANUAL

- A. Prior to completion of the project, compile a complete equipment Operation & Maintenance Manual for all equipment supplied under Division 26.
- B. Schedule:
 - 1. Submit a preliminary copy of the manual not less than 30 days prior to Substantial Completion for review and comment.
 - 2. Submit the final version of the manual not more than 4 weeks after Substantial Completion of the project.
- C. Format: Submit manuals in the following format:
 - 1. PDF Electronic File: Assemble for each system and piece of equipment, a manual with a composite PDF file, electronically indexed. Provide a system table of contents file with hyperlinks to each of the individual equipment PDF files. Submit on digital media acceptable to the Engineer.
 - a. Name each indexed document file in the composite electronic index with the applicable item name. Include a complete electronically-linked operation and maintenance directory.
 - b. Enable inserted reviewer comments on draft submittals.
 - c. Provide an updated final copy, inclusive of all review comments, to the Engineer and Owner.
- D. Provide Operation & Maintenance Manuals for all systems, subsystems, and equipment that require operation and regular maintenance, or have replaceable parts.
- E. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, product data, manufacturer's maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below. In addition to requirements in this section, include operation and maintenance data required in individual specification sections.
- F. Source Information: List each system, subsystem, and piece of equipment included in the manual, identified by product name and arranged to match the manual's table of contents. For each product, list the name, address, and telephone number of the installer or supplier and maintenance service agent, and cross-reference the specification section number and title in the Project Manual.
- G. Product Data: Include the following information:
 - 1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on the Contract Documents.
 - 2. Approved submittals.

3. Include the following if not shown on approved submittals:
 - a. Product name and model number. Use designations for products indicated on the Contract Documents.
 - b. Manufacturer's name.
 - c. Equipment identification with serial number of each component.
 - d. Equipment function.
 - e. Operating characteristics.
 - f. Limiting conditions.
 - g. Performance curves.
 - h. Engineering data and tests.
- H. Operating Procedures: Include the following, as applicable:
 1. Startup procedures.
 2. Equipment or system break-in procedures.
 3. Routine and normal operating instructions.
 4. Regulation and control procedures.
 5. Instructions on stopping.
 6. Normal shutdown instructions.
 7. Seasonal and weekend operating instructions.
 8. Required sequences for electric or electronic systems.
 9. Special operating instructions and procedures, including precautions against improper use.
 10. Operating logs.
- I. Wiring Diagrams: Diagram of factory-installed wiring including any options as well as any field modifications.
- J. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
- K. Manufacturer's Maintenance Documentation: Include the following information for each component part or piece of equipment:
 1. Standard maintenance instructions and bulletins.
 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 3. Identification and nomenclature of parts and components.
 4. List of items recommended to be stocked as spare parts.
- L. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
 1. Test and inspection instructions.
 2. Troubleshooting guide.
 3. Precautions against improper maintenance.
 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.

5. Aligning, adjusting, and checking instructions.
 6. Demonstration and training video recording, if available.
- M. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
- N. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturer's maintenance documentation and local sources of maintenance materials and related services.
- O. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- P. Licenses: Include copies of any licenses with requirements, including inspection and renewal dates.
- Q. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
- R. Test Reports: Include a final approved copy of the factory and field testing reports.

1.12 WORK AND MATERIALS

- A. Unless otherwise specified, all materials must be new and of the quality specified. The workmanship shall be of a quality that is acceptable to the Engineer and Owner, and is equal to the standards of the trades. The Contractor must staff the project with sufficient skilled workmen, including a fully qualified construction superintendent, to complete the work in the time allotted. The superintendent must be qualified to supervise all of the work in his work category.
- B. Uniformity: Unless otherwise specified, provide all equipment and products of the same type or classification by the same manufacturer.

1.13 APPROVALS OF MATERIALS AND EQUIPMENT

- A. Refer to Division 01 specifications for description of material and equipment for prior approvals and substitutions.

1.14 COOPERATIVE WORK

- A. Correct without charge any work requiring alteration due to lack of proper supervision or failure to make proper provision in time. Correct without charge any damage to adjacent work caused by the alteration. Refer to Division 01 specifications for additional requirements.
- B. Cooperative work includes:
 - 1. General supervision and responsibility for proper location, rough-in, and size of work related to Division 26 but provided under other divisions of these specifications.
 - 2. Installation of sleeves, inserts, and anchor bolts for work under sections in Division 26.
 - 3. Sealing of penetrations through fire and smoke barriers caused by work installed as part of Division 26.

1.15 EXISTING MATERIALS AND EQUIPMENT

- A. Disposition: With the exception of items that are to be re-used or retained by the Owner, all other materials indicated to be removed shall be removed and disposed of by the Contractor. Items that are indicated to be retained or returned to the Owner shall be delivered to a storage area designated by the Owner.
- B. Unused Materials: All unused raceways, conductors, boxes, equipment, and miscellaneous materials shall be removed by the Contractor except where located within walls, below or above existing construction which is not being altered and would require removal and replacement of this existing construction. All visible raceways, conductors, boxes, equipment, and miscellaneous materials shall be removed and sealed or capped within wall, below floor, unless noted otherwise.
- C. Exterior Services: The Contractor shall be responsible for maintaining electrical and control service to the existing building during the construction period. Existing services are to be retained until such a time that the new services, if any, are completely installed and ready for use. Scheduling of service interruptions is to be coordinated with the Engineer and Owner.
- D. Disconnect, demolish, and remove electrical systems, equipment, and components that are indicated to be removed.
 - 1. Conduit to be Removed: Remove portion of conduit indicated to be removed and cap or plug remaining conduit with the same or compatible conduit material. Patch insulation, as required, to match adjacent areas.
 - 2. Conduit to be Abandoned In Place: Cap or plug conduit with the same or compatible conduit material.
 - 3. Equipment to be Removed: Disconnect services and remove equipment.

4. Equipment to be Removed and Reinstalled: Disconnect and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 5. Equipment to be Removed and Salvaged: Disconnect and remove equipment and deliver to the Owner.
- E. Continuity of Services in Existing Building: The Contractor shall permanently reroute existing electrical and control services or provide temporary connection as required to maintain service to existing receptacles, fixtures, and equipment in the building which are to remain in service.
- F. Rerouting and Relocation of Existing Electrical Equipment and Services in Existing Building:
1. General: The Contractor shall reroute/relocate all existing materials which are in conflict with the building alterations and which are required to be maintained in use.
 2. Existing Raceways and Conductors: Where applicable, existing material may be re-used in its original location unless otherwise indicated.
- G. Testing: All existing services affected by the new construction and which are to remain in operation shall be returned to their original condition. The existing services shall be tested as new, as described in other sections of these specifications. If, for any reason, these requirements cannot be met, the Contractor shall immediately notify the Engineer.

1.16 GUARANTEE

- A. Guarantee in writing all material, equipment, installation, and workmanship for all sections under Division 26 to be free from defects of material and workmanship for 1 year from date of final acceptance as outlined in Division 01 specifications. Equipment warranties shall be a minimum of 1 year from date of Substantial Completion or as specified elsewhere. Refer to the specific product specification section for additional warranty terms. Replace without charge any material or equipment proving defective during this period. The guarantee shall include performance of the equipment under all conditions of load, installing any additional items of control and/or protective devices as required.

1.17 ELECTRICAL WIRING

- A. Provide all line voltage power wiring, line voltage interlock wiring, and line voltage control wiring for the equipment that is to be provided under Divisions 21, 22, and 23 unless wiring is specifically shown on the electrical drawings.

- B. The following schedule is intended to summarize the division of work material responsibilities between the Mechanical Contractor, Controls Contractor, and Electrical Contractor.

Item	Furn. By	Set By	Power Wiring	Control Wiring
Equipment Motors	MC	MC	EC	--
Motor Control Center	EC	EC	EC	CC
Motor Starters, Controllers, Contactors, and Overload Heaters	MC*	EC**	EC	CC
Fused and Non-Fused Disconnect Switches	EC	EC	EC	--
Manual Operating Switches, Multi-Speed Switches, Pushbutton Stations, and Pilot Lights	CC	CC	CC	CC
Control Relays and Transformers	CC	CC	CC	CC
Line Voltage Thermostats and Time Switches***	MC	MC	EC	EC
Low-Voltage Thermostats	MC	MC	--	MC
Temperature Control Panels	MC	MC	EC	CC
Smoke Detectors (Duct Mounted)	EC	MC	EC	MC or CC
Motor and Solenoid Valves, Damper Motors, PE and EP Switches	CC	MC	CC	CC
Water Treatment Equipment	MC	MC	EC	CC
<p>MC = Mechanical Contractor CC = Controls Contractor EC = Electrical Contractor</p> <p>*Except where such devices are located in MCCs.</p> <p>**Unless required by these specifications to be provided as part of a factory-furnished assembly (i.e., fan coils, air handlers, chillers, etc.).</p> <p>***Motor-drive units which are controlled from line voltage automatic controls such as line voltage thermostats, float switches, or time switches which conduct full load current of the motor shall be wired for both power and control under the electrical contract.</p>				

PART 2 PRODUCTS

2.01 CONCRETE

- A. Where used for structures to be provided under the contract such as bases, pole bases, etc., concrete work and associated reinforcing shall be as specified under that division.

- B. Refer to other sections for additional requirements for underground vaults, duct banks, etc.

2.02 FRAMING CHANNEL

- A. The framing channel shall be a cold-rolled, high-quality, carbon-steel channel with factory-applied, hot-dipped-after-fabrication galvanized finish. Utilize factory-built interconnecting components, mounting straps, connectors, etc., designed for use with the framing channel supplied. Channel nuts shall be spring type and shall utilize standard SAE threads. Provide heavy zinc paint for field touchup. B-Line “B” Series, Unistrut “P” Series, or as accepted by the Engineer.

2.03 ROOFTOP SUPPORTS

- A. Where specifically allowed by Part 3, provide pyramid-style composite support base for conduit, cable tray, and equipment. Support base shall be made of a UV-stabilized composite thermoplastic material or UV-resistant rubber and include hot-dip galvanized-steel attachment components. Rubber support base must include a steel load distribution top plate or strut. Support base shall include a low abrasion interface between the base and roof membrane for roof membrane protection. The base thermoplastic or rubber shall be made of 100% recycled material.
- B. Support base shall not have sharp edges and shall be compatible with project roof surfaces including single ply, bituminous, rubberized membrane, metal, and spray foam.
- C. Manufacturer and Product: nVent/Erco Caddy “Pyramid Base” Series, Eaton “Dura-Blok” Series, or as accepted.

2.04 ANCHORS

- A. Anchors shall be expandable-lead type, as manufactured by Ackerman-Johnson, Diamond, Hilti, Pierce, or as accepted by the Engineer.
- B. Adjustable concrete hanger inserts shall be as manufactured by Grinnell, or as accepted by the Engineer.

PART 3 EXECUTION

3.01 SUBMITTALS

- A. Prepare submittals as directed for review by the Contractor, Owner, and Engineer.

- B. Submit one copy of PDF submittals via email, project website, or other electronic media.

3.02 AS-BUILT DRAWINGS

- A. Recording: Post changes and modifications to the As-Built Drawings as they occur; do not wait until the end of the project.
- B. Maintenance of the As-Built Drawings, Submittals, and Shop Drawings: Store As-Built documents in the field office apart from the Contract Documents used for construction. Do not use project As-Built documents for construction purposes. Maintain As-Built documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project As-Built documents for the Engineer's reference during normal working hours. The As-Built Drawings will be reviewed by the Owner and Engineer at each pay request review.
- C. Submit the As-Built Drawings to the Engineer at the completion of the project.

3.03 OPERATION & MAINTENANCE MANUALS

- A. Prepare Operation & Maintenance Manuals as directed.
- B. Submit a preliminary electronic copy of the Operation & Maintenance Manual to the Engineer for review.
- C. Upon receipt of comments, make any corrections noted from the Engineer's review and resubmit as required.
- D. Submit the final, corrected Operation & Maintenance Manual in electronic format to the Engineer.

3.04 VERIFICATION OF DIMENSIONS

- A. Scaled and figured dimensions are approximate only. Before proceeding with work, carefully check and verify dimensions at the site, and be responsible for properly fitting equipment and materials together and to the structure in spaces provided.

3.05 EQUIPMENT LAYOUT

- A. Drawings are diagrammatic and many offsets, bends, pull boxes, special fittings, and exact locations are not indicated. Carefully study drawings and premises in order to determine best sequence and installation methods, exact locations, feeder and branch circuit routes considering building obstructions and other project limitations.

- B. All equipment furnished with connections in the required locations shall fit the space available and include adequate space for operating and servicing.
- C. Install apparatus and equipment in a manner and in locations to avoid obstructions, preserve headroom, and keep openings and passageways clear.
- D. Do not install conduit runs or cable trays in front of or directly below any portion of the equipment access areas where access would be blocked by the installation.
- E. Do not install conduit runs or cable trays in the path of equipment removal for repairs and or maintenance.

3.06 CUTTING AND PATCHING

- A. Cut work and patch per Division 01 specifications as necessary to properly install the new work. As the work progresses, coordinate necessary openings, holes, chases, etc., in their correct location. If the required openings, holes, and chases are not in their correct locations, make the necessary corrections at no cost to the Owner. Avoid excessive cutting and do not cut structural members without the consent of the Engineer. Include as a part of the work all structural framing required by penetrations through the roof and necessary steel to support electrical equipment and raceways between structural steel unless shown on the structural drawings.

3.07 CLOSING-IN OF UNFINISHED WORK

- A. Cover no work until inspected, tested, and approved. Where work is covered before inspection and test, uncover it, and when inspected, tested, and approved, restore all work to original proper condition.

3.08 ACCESSIBILITY

- A. Install all control devices or other specialties requiring reading, adjustment, inspection, repairs, removal, or replacement conveniently and accessibly throughout the finished building. Where any of these devices are shown on the Contract Drawings to be installed above any inaccessible ceiling or behind any inaccessible wall, the Electrical Contractor shall furnish access doors or panels as required.
- B. All access doors or panels in walls and ceilings required for access to control devices, control transformers, relays, power packs, and similar devices are to be furnished and installed as part of the work under this section. Provide type as specified in Division 08 specifications.
- C. Refer to the architectural drawings for type of wall and ceiling in each area and for rated construction.

- D. Coordinate work of various sections to avoid unnecessary duplication of access doors.
- E. Provide doors that pierce a fire separation with the same fire rating as the separation.

3.09 ROOF FLASHINGS

- A. Flash and counterflash all raceways penetrating roofing membrane with flashing per roofing manufacturer's recommendations. Refer to the architectural drawings for detailing of raceway penetrations through roof.

3.10 PRODUCT AND EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. All equipment, detectors, etc., shall be installed in strict conformance with the manufacturer's recommendations and all codes.
- B. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.
- C. Install equipment and raceways level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- D. Install electrical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations.
- E. Install equipment and raceways to allow right-of-way for access to removable panels and service points. This applies to equipment of all disciplines.
- F. Do not install any equipment in an application not recommended by the manufacturer.

3.11 EQUIPMENT ROUGH-IN

- A. Rough-in all equipment and fixtures as designated on the drawings and in the specifications. The drawings indicate only the approximate location of rough-ins. The exact rough-in locations must be determined from large-scale certified drawings. The Contractor shall obtain all certified rough-in information before progressing with any work for rough-in final connections.
- B. Be responsible for providing all outlets and services of proper size at the required locations.
- C. Minor changes in the Contract Drawings shall be anticipated and provided for under this division.

1. Rough-in only (unless otherwise designated on the drawings) shall include providing all services as indicated and required, including all raceway, conduit, and conductors. Cap all conduit stubouts in a manner suitable for future extension.

3.12 OWNER-FURNISHED AND OTHER EQUIPMENT

- A. Rough-in only for all Owner-furnished equipment (refer to Division 01 specifications) and all equipment furnished under other sections of the specifications, except as otherwise specified and/or noted on the drawings.
- B. Obtain rough-in drawings from the Owner or other contractors, prior to roughing-in any services.
- C. Provide all services required. Cap all conduit and raceways and leave in a clean and orderly manner.

3.13 EQUIPMENT FINAL CONNECTIONS

- A. Provide all final connections for the following:
 1. All equipment furnished under this division.
 2. Electrical equipment furnished under other sections of the specifications (except as otherwise designated).
 3. Owner-furnished equipment as shown on the drawings.

3.14 WIRING OF EQUIPMENT FURNISHED UNDER OTHER SECTIONS

- A. All electrical wiring including power wiring and control wiring (except as specified in Divisions 21, 22, and 23), including all raceways, wiring, outlet and junction boxes, and labor for installation of the wiring and equipment, shall be included in this section of the specifications.
- B. Wiring diagrams, complete with all connection details, shall be furnished under each respective section.
- C. Provide all connections as described per Divisions 21, 22, and 23.

3.15 EQUIPMENT SUPPORTS

- A. Erection of Metal Supports and Anchorages:
 1. Refer to Division 05 specifications for structural steel.
 2. Design, cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment. Neatly fabricate and erect steel work with burrs and welding spatter ground off. Paint after fabrication with a rust-inhibitive primer.
 3. Field Welding: Comply with AWS D1.1.

- B. Erection of Wood Supports and Anchorages:
 - 1. Design, cut, fit, and place wood grounds, nailers, blocking, and anchorages to support and anchor electrical materials and equipment.
 - 2. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
 - 3. Attach to substrates as required to support applied loads.
- C. Where supports, foundations, suspended platforms for transformers, or other equipment are indicated or specified, perform the following:
 - 1. Locate support members to avoid equipment stresses and interference with conduit connections, service panel removal, or other maintenance operations.
 - 2. Regarding equipment of other disciplines, locate support members to avoid interference with duct, conduit, and piping connections, control connections, service panel removal, or other maintenance operations.
- D. Rooftop supports shall not be used for conduit unless specifically noted on the plans. Where used, coordinate acceptability of support to membrane interface with roof membrane manufacturer and provide accordingly.
- E. Concrete Inserts: Furnish and install all concrete inserts required for all materials and equipment specified and/or shown on the drawings for Division 26.
- F. Concrete Bases: Work under this section includes coordination of construction of all concrete foundations indicated or required for equipment specified under Division 26. Materials and workmanship shall be described in Division 03 specifications. Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 1 inch (25 mm) larger in both directions than supported unit footprint. Where servicing apparatus for drawout circuit breakers requires a level surface in front of the switchboard or switchgear, coordinate pad front extension so as to allow service to occur using standard apparatus. Where utility company connections and equipment occur, pads below underground pull section, meter, and main switch(es) shall conform to the serving utility requirements.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extends through concrete base, and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use supported equipment manufacturer's installation drawings, templates, diagrams, and instructions to locate anchors. Install anchor bolts to elevations and embedment depths required for proper attachment to supported equipment.
5. Install anchor bolts at elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

G. Grouting:

1. Grout under lighting pole base plate after leveling, filling completely the space between base plate and foundation surface as specified in Division 03 specifications.
2. Mix and install grout for electrical equipment base bearing surfaces and other equipment base plates, and anchors.
3. Clean surfaces that will come into contact with grout.
4. Provide forms as required for placement of grout.
5. Avoid air entrapment during placement of grout.
6. Place grout, completely filling equipment bases.
7. Place grout on concrete bases and provide smooth bearing surface for equipment.
8. Place grout around anchors.
9. Cure placed grout.
10. Finish exposed surface of grout for a neat appearance.

3.16 CLEANUP

- A. In addition to cleanup specified in Division 01 specifications, thoroughly clean all parts of the equipment. Where exposed parts are to be painted, thoroughly clean off any splattered construction materials and remove all oil and grease spots. Wipe the surface carefully and scrape out all cracks and corners.
- B. During the progress of the work, keep the premises clean and free of debris.

3.17 PAINTING

- A. Except as otherwise specified or indicated in the architectural drawings and/or specifications, paint all exposed unfinished metal with one coat of rust-inhibiting primer. Galvanized and factory-painted equipment shall be considered as having primed surface.
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.
- C. Finished painting is specified in Division 09 specifications.

3.18 FIRESTOPPING

- A. Coordinate with the firestopping installer for sealing of all penetrations of fire and smoke barriers and other rated assemblies created during the installation of the Division 26 work.

3.19 OBJECTIONABLE NOISE AND VIBRATION

- A. Construct and brace sheet metal housings to prevent vibration or rattling when systems are in operation. Install connections to equipment so noise and vibration will not reach the conditioned area through conduit, sheet metal work, or the building structure.

3.20 TESTING

- A. Upon completion of the electrical work, the entire installation shall be tested and demonstrated to be operating satisfactorily. Tests and documentation shall be in accordance with NETA Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems.
- B. Tests, calibrations, and settings shall include the following:
 - 1. Wiring shall be tested for continuity, short circuits, and/or accidental grounds. All systems shall be entirely free from grounds, short circuits, and any or all defects.
 - 2. Motors shall be operating in proper rotation and control devices shall be functioning properly. Check all motor controllers to determine that properly sized overload devices are installed. Check all electrical equipment for proper operation.
 - 3. Insulation resistance test for all switchboard buses, bus ducts, motor and feeder conductors, including neutrals, using a megohmmeter. Apply to each conductor and maintain for 15 seconds or until reading stabilizes. Minimum value for each conductor shall be 20 megohms at 30°C. This test shall be performed by an independent testing company.
 - 4. Test, calibrate, and set all relays, circuit breaker trip devices, and ground fault protection trip units after receipt of engineered settings. Circuit breaker setups shall be performed or witnessed by a qualified representative of the circuit breaker manufacturer. This representative shall be identified by name and shall initial related test report(s).
 - 5. Additional equipment-specific testing is described in the equipment's respective section of this division.
- C. Furnish a written report of testing to the Engineer. At a minimum, the report shall include:
 - 1. Testing Contractor's letterhead.
 - 2. Testing technician's name and signature.
 - 3. Date and time that test was performed.

4. Ambient temperature and weather conditions.
 5. Test equipment manufacturer, model number, and last calibration date.
 6. The manufacturer, model number and, as applicable, trip unit model number and available adjustments of tested equipment.
 7. Statement of “As Left” conditions.
 8. Pass/Fail statement relative to NETA Chapter 10 recommendations.
 9. Recommendations if any.
- D. The Contractor shall submit the testing schedule to the Engineer 2 weeks prior to initiation of testing activity.
- E. Ground fault protection (GFP) trip units shall be calibrated and tested prior to energizing any equipment served by GFP devices.
- F. The Contractor shall furnish the necessary instruments and labor required for testing, calibration, and implementation of engineered settings.
- G. Tests and adjustments shall be made prior to acceptance of the electrical installation by the Engineer, and a certificate of inspection and acceptance of the electrical installation shall be provided by local inspection authorities.
- H. Any equipment or wiring provided, which through testing proves to be defective or operating improperly, shall be corrected or replaced promptly, at no additional cost to the Owner.

END OF SECTION

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SECTION 26 05 02

TEMPORARY & REMODELING WORK

PART 1 GENERAL

1.01 SUMMARY

- A. Perform all temporary and remodeling work as shown on the drawings and described in the specifications, including minor items of material or equipment necessary to meet the requirements and intent of the project.
- B. All temporary and remodeling work shall be considered a part of this contract and no extra charges will be allowed.
- C. Examine architectural, structural, and mechanical drawings and specifications to determine the sequence of construction throughout the project, including existing, temporary, remodeled, and new areas.
- D. Where drawings indicate existing conditions, an attempt has been made to show electrical equipment, buildings, site details, etc., but accuracy cannot be guaranteed. Verify exact location of all conduits, outlets, etc., and all building and site details.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 INSTALLATION

- A. Branch circuits shall be re-used where practical and shall, in addition, be revised as required. Conceal all work where possible. Where exposed work is required in finished areas, use Wiremold or similar raceway system components as approved by the Engineer.
- B. Existing electrical wiring intended to remain in use but which will be disturbed due to construction changes required by this Contract shall be restored to operating condition, as required and/or directed. Where required, shown, and/or directed, outlets and conduit runs shall be relocated. In some cases, it may be necessary to extend conduits and pull in new wiring or install junction boxes and splice in new wiring, or replace old wiring with new.
- C. Outlets from which lighting fixtures, switches, receptacles, and/or other electrical devices are removed and are not intended to be re-used shall be removed or, if it is not possible to remove them, a blank cover shall be placed on the outlet box. Where outlets, boxes, etc., are completely removed, the Contractor shall cut off conduits and remove wiring.

- D. Where conduits extending through floors are to be abandoned, the Contractor shall cut and cap or plug conduit so that it will not protrude above the floor.
- E. Where existing conduit is to be abandoned, the conduit shall be removed if it is exposed, in a crawl space, or in an accessible ceiling. Where it is impossible to remove the conduit, it shall be cut off and capped or plugged.
- F. The Contractor shall be held fully responsible for the proper restoration of all existing surfaces requiring patching, plastering, painting, and/or other repair due to the installation of electrical work under the terms of this specification. Close all openings, repair all surfaces, etc., as required.
 - 1. The Contractor shall employ qualified and experienced workmen for this work. All restoration work shall be subject to the approval of the Engineer and/or the Owner.

END OF SECTION

Edition: L-1907

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS & CABLES

PART 1 GENERAL

1.01 SUMMARY

- A. Furnish and install wire and cable for branch circuits and feeders as specified herein and as shown on the drawings.

1.02 RELATED SECTIONS

- A. Specification Section 26 05 53, Identification for Electrical Systems.

1.03 ACTION SUBMITTAL

- A. Submit product data indicating compliance with this specification for each type of conductor and cable.

PART 2 PRODUCTS

2.01 WIRE AND CABLE

- A. All wire and cable shall be new, 600-volt insulated, of types specified below for different applications. All wire and cable shall bear the UL label and shall be brought to the project in unbroken packages.
- B. Wire and cable #4 AWG size and smaller shall be Type THHN/THWN-2. Wire and cable larger than #4 AWG shall be Type XHHW-2.
- C. Wire and cable supplying Divisions 23, 24, and 25 equipment (and similar) shall be Type XHHW-2 regardless of size.
- D. Conductor Material:
 - 1. Annealed copper for all sizes. General Cable, Rome, Southwire, or as accepted.
- E. Conductor Stranding:
 - 1. Wire size #14 through #10 AWG shall be solid; wire size #8 AWG and larger shall be stranded.
- F. Wire Pulling Lubricant:
 - 1. American Colloid "Slip X-300."
 - 2. American Polywater A, C, G, & J.
 - 3. Electro "Y-er Eas."

4. Ideal “Wire Lube.”
5. Mac “Wirepull.”
6. Minerallac “Wire-Wax.”
7. Quelcor “Quelube.”
8. Richards “Gel Lube 7/5.”

G. Thomas/Jet Line “Slipry Loob.” Metal-clad (MC) cable shall be steel corrugated interlocking type and shall include an equipment ground conductor. Where used in medical applications, MC cable shall be hospital grade, steel corrugated interlocking type, and shall include an equipment ground conductor listed for use in NEC 517.13 systems. AFC, AmerCable, or as accepted. MC cable shall not be permitted to be used on this project unless indicated on the drawings or as noted in PART 3 of this section.

H. Armor-clad (AC) cable shall not be permitted to be used on this project.

2.02 TERMINATIONS, SPLICES, AND JOINTS

A. Terminations:

1. Locking fork, 600-volt vinyl insulated, butted seam, 3M Scotchlok terminals or as accepted.
2. Ring tongue, 600-volt vinyl insulated, butted seam, 3M Scotchlok terminals or as accepted.
3. Round flange solderless lug. Burndy “Quick-Lug” Type QDA, or as accepted.
4. Solderless lug with water-resistant self-sealing gel cover. RayChem GelCap, or as accepted.
5. Mechanical lug type listed for the application. Lug shall include an insulating cover. Burndy, Ilsco, or as accepted.
6. Flexible ferrule, copper, 600-volt, non-insulated. Dottie, NSi Industries, or as accepted.
7. Termination of stranded wire #10 AWG or smaller on breakers and wiring devices shall include a captive plate design.

B. Splices and Joints:

1. Pressure-type solderless insulated square spring connectors. Buchanan BCAP, 3M Scotchlok, Ideal Wire-Nut, Ideal Wing-Nut, or as accepted.
2. Solderless mechanical in-line lug with formed insulating cover, 600-volt minimum rating. Material shall be listed for use with the specific conductor material. Blackburn, Burndy, Ilsco, NSi, Panduit, or as accepted.
3. Irreversible compression type, long barrel with dimpled center stop and heat or cold shrink 600-volt insulation. Splice material shall match conductor material. Blackburn, Burndy, Ilsco, or as accepted.

4. Exterior Below Grade Joints in Wire (specific, case-by-case approval by the Engineer is required):
 - a. Pressure-type solderless insulated square spring connectors with self-sealing gel, UL 486D listed. Ideal Underground or as accepted.
 - b. Solderless lug, solderless compression lug with watertight self-sealing gel cover. Raychem GelCap or as accepted.
- C. Wire Taps: Solderless mechanical or compression lug, irreversible compression “H” tap, each with formed insulating cover or heat/cold shrink insulation, 600-volt minimum rating. Tap material shall be listed for use with the specific conductor material. Blackburn, Burndy, IlSCO, or Raychem Gtap, or as accepted.

2.03 APPLIED INSULATION

- A. Insulating materials shall be listed for the application. Voltage rating shall be equal to or greater than the factory-applied wire insulation. 3M, IlSCO, Raychem, or as accepted.

PART 3 EXECUTION

3.01 GENERAL WIRING

- A. Drawings, in general, indicate location of items of equipment. Exact locations of motors and other devices are to be determined in the field by the Contractor. Provide an electrical feed for all equipment, not smaller than shown or NEC size where size is omitted from drawings, together with a suitable circuit protective device. Verify panel schedules and layout, maintaining number of spare branches indicated.
- B. Complete rough-in requirements of all equipment to be wired under the Contract are not indicated. Coordinate with respective trades furnishing equipment or with the Engineer, as the case may be, for complete and accurate requirements to result in a neat, workmanlike installation.
- C. Feeder conductors to distribution equipment shall be adjusted to limit voltage drop. The Contractor shall review the anticipated installed length and confirm the selected feeder results in not more than 2% voltage reduction. Base calculations on the actual load, or where the actual load is not known, 80% of the load side equipment bus rating.
- D. Conductors for branch circuit lighting, receptacle, power, and miscellaneous systems shall be as stated in this section. Wire indicated specifically to be larger than the specified minimum shall be increased for the entire length of the circuit.

- E. Conductor sizes for lighting, receptacles, and small motor branch circuits with less than a 20-amp connected load are not shown. Conductors for such circuits are sized as follows for a 3% voltage drop to single load. Submit alternate lengths with supporting calculations for review prior to installation.

BRANCH CIRCUITS		
Voltage	Length (From Branch Circuit Panel to Load)	Conductor Size (Not Smaller Than)
120 Volt	66 Feet	No. 12 (16 Amps)
120 Volt	102 Feet	No. 10 (16 Amps)
120 Volt	163 Feet	No. 8 (16 Amps)
120 Volt	256 Feet	No. 6 (16 Amps)
208 Volt	114 Feet	No. 12 (16 Amps)
208 Volt	177 Feet	No. 10 (16 Amps)
208 Volt	283 Feet	No. 8 (16 Amps)
208 Volt	443 Feet	No. 6 (16 Amps)
277 Volt	153 Feet	No. 12 (16 Amps)
277 Volt	236 Feet	No. 10 (16 Amps)
277 Volt	376 Feet	No. 8 (16 Amps)
277 Volt	590 Feet	No. 6 (16 Amps)

3.02 INSTALLATION

- A. Wire and cable shall be pulled into conduits without strain, using an approved lubricant.
- B. In no case shall wire be re-pulled if same has been pulled out of a conduit run for any purpose.
- C. No conductors shall be pulled into conduit until conduit system is complete, including junction boxes, pull boxes, etc.
- D. Feeder conductors shall be installed without splicing except where run length is in excess of 500 feet.
- E. All connections to wiring devices, circuit breakers, switches, fixtures, motors, and all joints in wires shall be made as noted below:
1. Terminations at Wiring Devices:
 - a. #12 AWG solid wire formed around binding post or screw.
 - b. #14 through #10 AWG stranded wire, locking fork tongue where terminals do not have a captive plate.
 - c. #8 AWG and larger, terminate via splice to device modular connector pigtails.
 2. Terminations at Circuit Breakers and Switches:
 - a. #14 through #10 AWG stranded wire, locking fork tongue where terminals do not have a captive plate.

- b. #8 AWG and larger wire, where device does not include a captive plate or factory-provided lug, utilize a ring tongue.
 - c. #6 AWG and larger wire, round flange solderless lug, Burndy “Quick-Lug” Type QDA, or as accepted.
3. Motor Connections: Solderless lug with water-resistant self-sealing gel cover.
4. Joints in Wire:
 - a. #8 AWG and smaller wire, pressure-type solderless square spring connectors.
 - b. #6 AWG and larger wire, irreversible compression type, long barrel.
 - c. Wire Taps: Solderless compression lug, irreversible compression “H” tap. Material shall be listed for use with the specific conductor material.
 - d. Exterior Below Grade Joints in Wire (specific, case-by-case approval by the Engineer is required): Solderless lug, solderless compression lug.
 - 1) #6 AWG and Smaller Wire: Pressure-type solderless square spring connectors with self-sealing gel.
 - 2) Larger Than #6 AWG Wire: Solderless lug, solderless compression lug with watertight self-sealing gel cover.
5. Solderless connectors NOT used for grounding shall be insulated. Applied wire insulation voltage rating shall be equal to or greater than the factory-applied wire insulation. Insulate by one of the following methods:
 - a. One or more layers of rubber tape, equal in thickness to the conductor insulation, followed by two layers of electrical vinyl tape.
 - b. Pre-manufactured insulating caps.
 - c. Heat or cold shrink insulating sleeve or tape. Shrink in accordance with the manufacturer’s recommendations.
6. Wire compression-type sleeves or lugs shall be installed with the manufacturer’s recommended tool, in accordance with their published instructions.
7. Other Equipment: Use mechanical lug furnished with the equipment or listed for the application.
8. Termination of finely stranded conductor, such as Type W, shall be made using a flexible ferrule.
9. Each conductor termination shall be tightened to the torque value recommended by the termination manufacturer. Terminations shall be marked once the final torque has been applied. Torque wrenches used for this purpose shall be calibrated and certified per NETA recommendations.

3.03 COLOR CODING AND MARKING

- A. All wiring throughout shall be color-coded as follows:

	480-Volt System	208-Volt System
A Phase	Brown	Black
B Phase	Orange	Red
C Phase	Yellow	Blue
Neutral*	Grey	White
Ground	Green	Green
Iso Ground		Green with Yellow Stripe

*Where multiple neutrals are installed within the same raceway, each individual neutral shall be distinctly identified by one or more color stripes.

- B. All control wiring in a circuit shall be color-coded, each phase leg having a separate color, and with all segments of the control circuit, whether in apparatus or conduit, utilizing the same color-coding.
- C. Wiring must be color-coded throughout its entire length, except that feeders may have color-coded plastic tape at both ends and all accessible points.
- D. At all terminations of control wiring, the wiring shall have a numbered wire marker.
- E. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.04 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Specification Section 26 05 44, Underground Pull Boxes & Handholes.

3.05 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Specification Section 07 84 13, Penetration Firestopping.

END OF SECTION

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SECTION 26 05 26

GROUNDING & BONDING OF ELECTRICAL EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. Furnish and install grounding and grounding conductors as specified herein and as shown on the drawings.

1.02 ACTION SUBMITTAL

- A. Submit product data indicating compliance with this specification for each type of ground system component.
- B. Submit ground system test reports to the Engineer for review.

1.03 CLOSEOUT SUBMITTAL

- A. Include final ground system test reports in the project Operation & Maintenance Manual.

PART 2 PRODUCTS

2.01 CONDUCTORS

- A. Insulated Conductors: Stranded copper with 600-volt green insulation.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B3.
 - 2. Stranded Conductors: ASTM B8.
 - 3. Tinned Conductors: ASTM B33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of #17 AWG conductor, 1/4 inch (6 mm) in diameter.
 - 5. Bonding Conductor: #4 or #6 AWG, stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

2.02 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory (NRTL) acceptable to Authorities Having Jurisdiction for applications in which used

and for specific types, sizes, and combinations of conductors and other items connected.

- B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- C. Ground Busbar Connectors: Tin-plated copper, two-hole, long-barrel solderless compression type with inspection window.
- D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual tin-plated or silicon bronze bolts.
- E. Cable End-to-End Splices: Tin-plated copper, long barrel, end-to-end compression connectors. Provide with listed shrink on insulation.
- F. Cable Tap Splices: Tin-plated copper, heavy-duty C-tap compression connectors for splices where all conductors are #2 AWG or smaller. Tin-plated copper H-tap compression connectors with insulative cover for all other splices.
- G. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.
- H. Conduit Hubs: Mechanical type, terminal with threaded hub.
- I. Ground Rod Clamps: Mechanical type, copper or copper alloy terminal with hex head bolt, listed for direct burial. Manufactured by Burndy, Ilasco, Blackburn, or as accepted.
- J. Flexible Ground Straps: Copper, flat-braided type with formed single-hole end pads.
- K. Rod and Pipe Clamps: Silicone bronze ground clamp up to 4-inch nominal pipe diameter. Field-welded bonding tabs for two-hole connectors for larger sizes.

PART 3 EXECUTION

3.01 APPLICATIONS

- A. All panelboard cabinets, equipment, enclosures, and conduit systems shall be grounded securely in accordance with pertinent sections of the NEC, as amended by any local codes. Conductors shall be copper. All electrically operated equipment shall be bonded to the grounded conduit system. All non-current-carrying conductive surfaces that are likely to become energized and subject to personal contact shall be grounded by one or more of the methods detailed in the NEC. All ground connections shall have clean contact

surfaces. Install all grounding conductors in conduit and make connections readily accessible for inspection.

- B. Grounding of metal raceways shall be assured by means of grounding bushings on feeder conduit terminations at the service entrance, distribution switchboards, and panelboards, and by means of a continuous, stranded, copper grounding wire extended from the ground bus in the enclosure to the conduit grounding bushings.
- C. A separate insulated grounding conductor, sized per the NEC, shall be installed in all electrical metallic tubing (EMT).
- D. Where grounding and bonding conductors are installed in metallic conduit, each end of the raceway shall be bonded to the grounding conductors by means of listed bond bushings. Where bushings are not available for the conduit and cable size, listed pipe clamps may be used in lieu of bushings.
- E. All interior connections shall be mechanical or compression type.
- F. All grounding conductors shall maintain a downward or horizontal direction where possible. Minimum bending radius of ground conductors shall be 8 inches.
- G. Do not encircle ground cables completely with magnetic metal (i.e., conduit straps, junction boxes, etc.). Use one-hole straps with nylon screws, fiberglass channel framing, or similar. Where encirclement cannot be avoided, provide a #6 AWG bond to the metal encirclement.
- H. Connections of Dissimilar Metals: Coat surfaces with “NO-OX-ID-A” compound.
- I. Air Plenums or Other Spaces used for Environmental Air: Insulated ground cables shall not be exposed within. Where routing or connections are required in such spaces, provide bare copper conductors.

3.02 SPLICES

- A. Where a splice is required, it shall be made with a UL Listed, irreversible compression-type connector or exothermic welding.
- B. Exothermic welds shall be cast with size-appropriate molds as recommended by the thermal weld manufacturer.

END OF SECTION



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SECTION 26 05 33

RACEWAY & BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. Furnish and install conduit and fittings as shown on the drawings and as specified herein.

1.02 COORDINATION

- A. It shall be the responsibility of the Contractor to consult the other trades before installing conduit and boxes. Any conflict between the location of conduit and boxes, piping, ductwork, or structural steel supports shall be adjusted before installation. In general, large pipe mains, waste, drain, and steam lines that pitch, large air ducts, and all structural steel shall be given priority.
- B. Conduit size shall be such that the required number and sizes of wires can be easily pulled in and the Contractor shall be responsible for the selection of the conduit sizes. Conduit sizes shown on the drawings are minimum sizes in accordance with appropriate tables in the National Electrical Code (NEC). If, because of bends or elbows, a larger conduit size is required, the Contractor shall so furnish without further cost to the Owner.
- C. The Contractor shall be entirely responsible for the proper protection of this work from the other trades on the project. When conduit becomes bent, holes are punched through same, or outlets are moved after being roughed-in, the Contractor shall replace same, without additional cost to the Owner.

1.03 RELATED SECTIONS

- A. Specification Section 26 05 53, Identification for Electrical Systems.
- B. Specification Section 26 27 26, Wiring Devices.

1.04 ACTION SUBMITTAL

- A. Submit product data indicating compliance with this specification for each type of box, conduit, raceway, fitting, wall and trench duct.
- B. Exposed Conduit Routing: Where conduit must be exposed in finished areas, submit a routing diagram to the Engineer for acceptance prior to installation. Submittal shall include sufficient detail to communicate the route vertically and horizontally with heights stated.

PART 2 PRODUCTS

2.01 GENERAL

- A. Conduit sizes for various numbers and sizes of wire shall be as required by NEC Chapter 9, but shall not be smaller than 3/4-inch size except as otherwise noted.
- B. Each length of conduit shall be stamped with the name or trademark of the manufacturer and shall bear the UL label for the specific product type.
- C. All concrete inserts and pipe clamps shall be galvanized. All steel bolts, nuts, washers, and screws shall be galvanized or cadmium plated. Individual hangers, trapeze hangers, and rods shall be prime-coated.
- D. Calibrated pull string/measuring tape shall be Greenlee Part No. 435, or as accepted.

2.02 CONDUIT

- A. Rigid galvanized steel (RGS), intermediate metallic conduit (IMC), and electrical metallic tubing (EMT) shall be Allied Tube & Conduit, Republic Conduit, Western Tube & Conduit Corp., Wheatland Tube Company, or as accepted.
- B. PVC-Coated RGS or IMC:
 - 1. Minimum Exterior PVC Coating: 40 mils bonded to the exterior surface.
 - 2. Minimum Interior Urethane Coating: 2 mils on both interior and steel threads.
 - 3. Listed as UL 6 and compliant with ANSI C80.1 and NEMA RN 1.
 - 4. Acceptable Manufacturers: Robroy Industries Plasti-Bond/KorKap/Perma-Cote, Thomas and Betts Ocal, or as accepted.
- C. Polyvinyl chloride (PVC) conduit shall be Cantex, Carlon, or as accepted.
- D. Liquid-tight flexible metallic conduit shall be Anaconda Sealtite Type UA, or as accepted.
- E. Conduit systems shall be color coded. Reference Specification Section 26 05 53, Identification for Electrical Systems, for additional requirements.

2.03 FITTINGS

- A. Couplings and connectors for RGS or IMC conduit shall be steel or malleable iron, threaded, and rain- and concrete-tight. Couplings and connectors that are exposed, installed in hollow construction, or above ceilings shall be

threaded, uncouple, or compression type. Steel compression-type fittings shall be used for interior EMT and metallic flex. Steel weathertight compression fittings shall be used for exterior EMT. Die-cast or pressure-cast EMT and metallic flex fittings shall NOT be allowed.

- B. Liquid-tight metallic flex connectors shall be steel or malleable iron.
- C. Bushings and locknuts shall be malleable iron with sharp, clean-cut threads.
- D. Fittings shall be Appleton, Crouse-Hinds, Steel City, T&B, or as accepted.
- E. Expansion joint fittings on RGS or IMC conduit shall be Crouse-Hinds Type XJ, or as accepted. Expansion joint fittings on PVC conduit shall be Carlon Type E945, or as accepted.
- F. Entrance seals shall be O.Z. Type FSK, or as accepted.
- G. Explosion-proof and temperature seals shall be listed for 40% fill application, vertical and horizontal, and shall be Appleton Type EY, or as accepted.
- H. Couplings and connectors for PVC conduit shall be of the same manufacturer as the conduit to be coupled or connected. Fittings shall be provided in accordance with the manufacturer's recommendations.

2.04 SURFACE RACEWAY

- A. Where devices are shown within the surface raceway, they shall meet the requirements of a "Multi Outlet Assembly" as described in Specification Section 26 27 26 Wiring Devices.

2.05 BOXES

- A. All boxes must conform to the provisions of NEC Article 314. All boxes shall be of the proper size to accommodate the quantity of conductors enclosed in the box. Boxes shall not be less than 4 inches square and 1-1/2 inches deep unless otherwise noted.
- B. Generally, boxes shall be hot-dipped galvanized steel with knockouts. Where recessed, boxes shall have square cut corners. Outlet, switch, and gang size junction boxes on exterior surfaces or in damp locations shall be corrosion-resistant, cast malleable iron. Boxes shall have threaded hubs for rigid conduit and neoprene gaskets for their covers. Boxes shall be Appleton Type FS or FD, Crouse-Hinds, or as accepted. Conduit bodies shall be corrosion-resistant, cast malleable iron, and shall have threaded hubs for rigid conduit and neoprene gaskets for their covers. Bodies shall be Appleton Unilets, Crouse-Hinds, or as accepted.

- C. Deep boxes shall be used in walls covered by wainscot acoustical wall panels or paneling and in walls of glazed tile, brick, or other masonry that will not be covered with plaster. The bottom of the box shall be located on the horizontal joint. Through-the-wall type boxes shall not be used unless specifically called for. All boxes shall be non-gangable. Boxes in concrete shall be of a type to allow the placing of conduit without displacing the reinforcing bars. All lighting fixture outlet boxes shall be equipped with the proper fittings to support and attach a light fixture.
- D. All light switches, receptacles, and similar outlets shall be provided with approved boxes, suitable for their function. Back boxes shall be furnished and installed as required for the equipment and/or systems under this Contract.
- E. Pull and junction boxes shall be substantially-made code-gauge boxes with screw covers. Boxes shall be rigid under torsional and deflecting forces and shall be provided with angle-iron framing where required. Boxes shall be 4 inches square with a blank cover in unfinished areas and with a plaster ring and blank cover in finished areas, and shall be installed where required to pull cable or wire, but only in finished areas by approval of the Engineer. Boxes shall be rigidly attached to the structure, independent of any conduit support. Boxes shall have their covers accessible. Covers shall be fastened to boxes with machine screws to ensure continuous contact all around. Covers for surface-mounted boxes shall line up evenly with the edges of boxes. Covers for flush-mounted oversize boxes shall extend 3/4 inch past the box all around. Covers for 4-inch square and 4-inch ganged boxes shall extend 1/4 inch past the box all around.
- F. Outlets are only approximately located on the plans and great care must be used in the actual location of outlets by consulting the various detailed drawings. Outlets shall be flush with finished wall or ceiling. Trim, cases, or other fixtures shall have their boxes installed symmetrically on such trim or fixture. Refer to the drawings for location and orientation of all outlet boxes.
- G. Furnish and install all plaster rings as may be required. Plaster rings shall be installed on all boxes where the boxes are recessed. Plaster rings shall be of a depth to reach the finished surface. Extension rings, where required, shall be installed so that the plaster ring is flush with the finished surface.
- H. Exterior gang-type boxes shall be cast type. Where any box occurs within 12 inches of the earth, provide cast iron type.
- I. Boxes with unused punched-out openings shall have the openings filled with factory-made knockout seals.

- J. Construct pull boxes and rack space for future conduits equal to 25% of present runs. Provide required barriers. Attach a plastic label to each pull box cover listing the feeder numbers enclosed within and the source of current. Identify each conduit at pull box termination with voltage and feeder number in red. Provide sufficient cable slack at terminations and in junction and pull boxes to allow for cable contraction and for future splicing. Fireproof cable in pull boxes where more than one feeder is enclosed.
- K. Boxes shall be as manufactured by Appleton, Raco, Steel City, or as accepted.

PART 3 EXECUTION

3.01 CONDUIT

- A. Applications:
 - 1. PVC conduit may be used for all exterior underground systems, in slab, below slab-on-grade, and in concrete or masonry walls. For medical applications, PVC conduit shall not be used to supply power to medical equipment or branch circuits in patient care areas, NO EXCEPTIONS.
 - a. All plastic conduit shall be rigid, Schedule 40, heavy wall PVC.
 - b. Install bell ends at all conduit terminations in manholes and pull boxes and under equipment.
 - c. All bends over 30 degrees shall be made with wrapped IMC.
 - d. Stubups below switchboard/switchgear equipment shall be between 1 and 2 inches above the floor surface with the bell fitting installed.
 - e. All plastic conduit, except that used for telephone, shall contain a code-sized bond wire.
 - 2. IMC shall be used for all conduit larger than 2 inches, and for all underground or in-slab conduit, except where PVC is permitted or where RGS is specified. IMC conduit shall be used in explosion-proof areas.
 - 3. RGS conduit shall be used in place of IMC or where it is specified on the plans.
 - 4. PVC-coated RGS (PVC-RGS) conduit shall be used in corrosive areas where exposed to physical damage, or where specified on the plans.
 - 5. Liquid-tight flexible metallic conduit, in lengths not exceeding 3 feet, shall be used to connect motors and transformers. Installation shall be such that considerable slack is realized. The conduit shall contain a separate grounding conductor.
 - 6. Galvanized steel, flexible metallic conduit, in lengths not exceeding 6 feet, shall be used to connect fire alarm, lighting fixtures, and wiring devices or equipment mounted in movable panels such as acoustical ceiling tiles, etc. Installation shall be such that considerable slack is realized. The conduit shall contain a separate grounding conductor. Connectors shall be steel or malleable iron. Factory supplied and listed lighting fixture whips are acceptable in lieu of flexible metallic conduit.

7. All other conduit shall be EMT. A separate insulated grounding conductor, sized per the NEC, shall be installed in EMT.
- B. Conduit shall be continuous from outlet to outlet, cabinet, or junction box, and shall be so arranged that wire may be pulled in with the minimum practical number of junction boxes.
- C. All conduit shall be concealed wherever possible. All conduit runs may be exposed in mechanical equipment rooms, electrical equipment rooms, and electrical closets, and where indicated on the drawings. No conduit shall be run exposed in finished areas without specific acceptance by the Engineer.
- D. Exposed conduit shall be run in straight lines at right angles to or parallel with walls, beams, or columns. In no case shall conduit be supported or fastened to other pipes or installed to prevent the ready removal of other pipe.
- E. Where possible, all conduit for wiring within stud or moveable partitions shall enter the partition from above.
- F. Provide sleeves and chases where conduit passes through floors or walls as part of the work of this section. Core drilling will only be permitted where accepted by the Engineer.
- G. Conduit stubbed up/down or through floor slabs shall be wrapped RGS or wrapped IMC with a minimum of 6 inches of conduit exposed out of slab for connection of threaded or compression fitting. Where conduit bends extend out of slab, the conduit shall be placed at the maximum allowable distance from the exit surface and shall have a bend radius as allowed by code to provide as true and square a conduit exit as possible. Conduit deck flanges will be used where conditions allow and where the flange can be tightly secured flush to the face of a concrete form.
 1. Exception: Conduit stubbed through slabs on grade into the bottom of full height switchboard/switchgear sections, floor mounted full height UPS sections, floor mounted full height automatic transfer switches, floor mount transformers and load banks.
- H. Openings through fire-rated floors and fire walls through which conduit passes shall be sealed by fire stop material to seal off cold smoke and toxic fumes. Fire-seal material shall have an hourly fire rating equal to or higher than the fire rating of the floor or wall through which the cable or conduit passes. Material used shall conform to the Authority Having Jurisdiction (AHJ) requirements. Openings through smoke walls through which cable or conduit passes shall be sealed with non-shrink, non-combustible material approved by the AHJ to seal off cold smoke and toxic fumes.

- I. Conduit above lay-in grid-type ceilings shall be installed in such a manner that it does not interfere with the “lift-out” feature of the ceiling system.
- J. Conduit runs shall be installed to maintain the following minimum spacing wherever practical:
 - 1. Water and Waste Piping: Not less than 3 inches.
 - 2. Steam and Condensate Lines: Not less than 12 inches.
 - 3. Radiation and Reheat Lines: Not less than 6 inches.
- K. All underground conduit outside of any buildings shall be a minimum of 24 inches below finished grade, except where noted otherwise on the drawings.
- L. All underground feeder conduit (this does not include branch circuits) outside of any buildings shall be concrete encased. Concrete shall be 3/8-inch aggregate with a nominal compressive strength of 2,500 PSI. It shall have enough slump to flow to the bottom of the duct formation and not so wet as to cause the ducts to float. Each conduit shall be completely encased in concrete not less than 3 inches all around. Concrete shall not be poured until conduit has been inspected by the Engineer. Separators or spacing blocks shall be made of plastic or other suitable non-metallic, non-decaying material placed on not greater than 5-foot centers. Ducts shall be anchored to prevent movement during placement of concrete.
- M. Provide corrosion protection for metallic conduit under concrete or in earth. Provide half-lap wrap of polyethylene 20-mil tape, factory PVC coating, or as accepted. Where PVC coating is provided, joints must be sealed in accordance with the coating manufacturer’s published instructions.
- N. PVC-coated RGS (PVC-RGS) joints must be sealed in accordance with the coating manufacturer’s published instructions. Installer shall be certified by the manufacturer and shall provide a valid, unexpired “Certified Installer” card prior to installing materials. Product manufacturer shall perform an inspection of the installed product and issue an acceptance report of the installation.
- O. Each empty conduit shall be provided with an installed nylon pull string.
- P. Each medical equipment conduit shall be provided with an installed calibrated pull string/measuring tape.
- Q. Bending: Changes in direction shall be made by bends in the conduit wherever possible, and these bends shall be made smooth and even without flattening the pipe or flaking the finish. Bends shall be of as long a radius as possible, but in no case less than shown in the NEC.

- R. Not more than four 90-degree bends will be allowed in one raceway run. Where more bends are necessary, a pull box shall be installed. All bends in 1-inch and smaller conduit shall be made with a conduit bender, and all larger conduit sizes shall have machine bends.
- S. Plastic conduit joints shall be made up in accordance with the manufacturer's recommendations for the particular conduit and coupling selected. Conduit joint couplings shall be made watertight. Plastic conduit joints shall be made up by brushing a plastic solvent cement on the inside of a plastic coupling fitting and on the outside of the conduit ends. The conduit and fitting shall then be slipped together with a quick one-quarter turn twist to set the joint tightly. Transition from plastic to steel conduit shall be with PVC female threaded adaptors.
- T. Plastic conduit shall be stored on a flat surface and protected from the direct rays of the sun.
- U. The ends of all conduit shall be securely plugged, and all boxes temporarily covered to prevent foreign material from entering the conduit. All conduit shall be thoroughly swabbed out with a dry swab to remove moisture and debris before conductors are drawn into place.

3.02 FITTINGS

- A. Bushings and Locknuts: Where conduit enters boxes, panels, cabinets, etc., it shall be rigidly clamped to the box by locknuts on the outside and inside, and a bushing on the inside of the box. All conduit shall enter the box squarely.
- B. Provide insulated bushings per the NEC on all conduit. The use of insulated bushings does not exclude the use of double locknuts to fasten conduit to the box.
- C. Provide expansion fittings for all conduit where it crosses building expansion joints, not to exceed 100 feet apart in straight runs. Fittings shall be complete with bonding jumpers and clamps and shall be suitably bonded to conduit.
- D. Provide weatherproof fittings in exterior installations or as noted on the plans.

3.03 SUPPORTS

- A. All raceways that are not buried or embedded in concrete shall be supported by straps, clamps, or hangers to provide a rigid installation.
- B. Conduit shall be supported at intervals required by the NEC, straight runs, at any bend, and at every outlet, junction box, panel, etc. This shall apply to vertical runs as well as horizontal runs. Where conduit is run individually, it shall be supported by approved conduit straps or beam clamps. Straps shall

be secured by means of toggle bolts on hollow masonry; expansion shields and machine screws or standard preset inserts on concrete or solid masonry; machine screws or bolts on metal surfaces; and wood screws on wood construction. No perforated straps or wire hangers of any kind will be permitted. Where individual conduits are suspended from the ceiling, or above ceiling, they shall be supported by hanger rods and hangers. Conduit installed exposed in damp locations shall be provided with clamp backs under each conduit clamp, to prevent accumulation of moisture around the conduit. Where a number of conduits are to be run exposed and parallel, one with another, they shall be grouped and supported by trapeze hangers. Hanger rods shall be fastened to structural steel members with suitable beam clamps or to concrete inserts set through the opening provided in the concrete inserts. Beam clamps shall be suitable for structural members and conditions. Rods shall be galvanized steel, 3/8-inch diameter minimum. Each conduit shall be clamped to the trapeze hanger with conduit clamps.

3.04 GENERAL

- A. Install all boxes parallel and perpendicular to the finished floor. Adjust all flush mounting positions to compensate for wall material thickness. Where devices occur in the same horizontal viewing plane, align devices.
- B. Where outlet boxes occur on opposite sides of a common wall, do not place back-to-back or use through-the-wall boxes, to limit sound transmission between rooms.
- C. Where fire-rated walls occur, all membrane penetrations shall comply with the International Building Code (IBC) for walls/partitions, and for floor-ceilings/roof-ceilings. Outlet boxes in rated walls shall be steel. Outlet boxes on opposite sides of a rated wall shall be separated by a minimum of 24 inches horizontally.
- D. Support all boxes independently of conduit, except cast type which may be supported by rigid steel conduit only. Secure flush-mount boxes to wall and interior partition studs using stamped steel bridges as required to accurately position boxes. Secure ceiling-hung boxes to adjustable steel channel fasteners.
- E. All cabinets and boxes shall be secured by means of toggle bolts on hollow masonry; expansion shields and machine screws or standard precast inserts on concrete or solid masonry; machine screws or bolts on metal surfaces; and wood screws on wood construction. All recessed wall- and ceiling-mounted outlet boxes shall be supported by bar supports extending from the studs or channels on either side of the box. Boxes mounted on the surface of drywall or plaster shall be secured to wall or ceiling with fasteners rated for the weight to be supported, minimum 50 lbs. per fastener.

- F. Boxes with unused punched-out openings shall have the openings filled with factory-made knockout seals.
- G. Where emergency power and normal power are located in the same outlet box or a potential of 480 volts is present in a switch box, install partition barriers to separate the various systems.

3.05 SEPARATE CONDUIT SYSTEMS

- A. Each system shall be contained in a separate conduit system. This includes each power system, lighting system, signal system of whatever nature, telephone, emergency system, emergency subsystems, sound system, control system, fire alarm system, etc.
- B. Each item of building equipment shall have its own run of power wiring. Control wiring may be included in properly sized conduit for equipment feeders of #6 AWG and smaller, but separate conduits shall be used for larger size feeders.

3.06 ROUTING AND EXPOSURE

- A. Where conduit and boxes must be exposed, submit a sketch of the proposed route to the Engineer for approval prior to installation.
- B. Where conduit is exposed to exterior ambient temperatures for more than 10% of its length or 10 feet, whichever is less, increase the conductor sizes in accordance with the application of ambient temperature factors contained in NEC Table 310.15.
- C. Conduit shall be installed at depths compliant with NEC Table 300.5.

END OF SECTION

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SECTION 26 27 26

WIRING DEVICES

PART 1 GENERAL

1.01 SUMMARY

- A. Furnish and install all wiring devices as shown on the drawings and as herein specified.

1.02 ACTION SUBMITTALS

- A. Product Data: Provide manufacturer's product information for each item, including but not limited to voltage and ampere ratings, materials, finishes, and related accessories.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Switches, Receptacles, and Device Plates: Basis of design is Hubbell. Product reference numbers contained herein are for standard products offered by Hubbell. Subject to compliance with requirements, equivalent products from manufacturers listed below are acceptable.
 - 1. Eaton/Arrow-Hart Wiring Devices.
 - 2. Legrand/Pass & Seymour.
 - 3. Leviton.
- B. Wall Box Dimmers: Basis of design is Lutron Electronics Co., Inc., Maestro Series. Product reference numbers contained herein are for standard products offered by Lutron. Subject to compliance with requirements, equivalent products from manufacturers listed below are acceptable.
 - 1. Hubbell Control Solutions #RS Series.
 - 2. Leviton #Decora Digital Series.
 - 3. nLight #nPODM Series.
 - 4. Sensor Switch #sPODM Series.
 - 5. Wattstopper #Radiant Series.
- C. Miscellaneous Devices: Manufacturers are noted in the product descriptions.

2.02 SWITCHES

- A. All LINE-VOLTAGE switches shall be of the quiet mechanical type, specification grade, 20 amps, 120/277 VAC as follows:

Device	Model No.
Single Pole	1221
Two Pole	1222
Three-Way	1223
Four-Way	1224
Pilot Light	1221PL 120V 1221PL7 277V
Single Pole – weatherproof neoprene cover	HBL1750
Single Pole – weatherproof neoprene cover with pilot light	HBL1785

- B. All LOW-VOLTAGE switches shall be of the quiet mechanical type, specification grade, 3-position, 2-circuit momentary contact, center off, 15 amps, 120/277 VAC as follows:

Device	Model No.
Toggle Type – Center Position	HBL1556

- C. Switch color shall be selected by the Engineer.
- D. All LINE-VOLTAGE switches shall have the ON and OFF positions indicated on the handle.
- E. If switches of higher ampere ratings are required, they shall be of similar type and quality to those shown above.

2.03 RECEPTACLES

- A. All convenience receptacles and special outlets throughout shall be grounding type.
- B. Receptacles shall be specification grade, back- or side-wired, parallel slot, 2-pole, 3-wire, 20 amps as follows:

Device	Model No.
Single	5361
Duplex	5362
Controlled – 50%	BR20C1

Device	Model No.
Controlled – 100%	BR20C2
Clock Outlet	HBL5235
Isolated Power	IG5362
Weather Resistant	BR20_WR
Tamper Resistant	5362TR
Ground Fault Circuit Interrupters	GFST20
Tamper Resistant & GFCI	GFTRST20
Surge Protected Receptacle	HBL5362_SA
Surge Protected & IG Receptacle	IG5362_SA
USB Charging Duplex	USB20X2
USB Charging Only	USB4

- C. If receptacles of higher ampere ratings are required, they shall be of similar type and quality to those shown above.
- D. Special receptacles shall be as noted on the drawings. Furnish caps for all special outlets.

2.04 DEVICE PLATES

- A. Provide wall plates for all wiring devices and outlet boxes, including special outlets, sound, signal, and telephone outlets, etc., as required. All cover plates shall be appropriate for type of device.
- B. All plates throughout shall be specification grade nylon, color to match wiring devices, EXCEPT:
 - 1. Where devices occur in mirrored surfaces, provide mirrored cover plates.
 - 2. Where devices occur in food service and kitchen areas, provide brushed stainless-steel cover plates.
- C. Where a receptacle is noted as weatherproof (WP), provide “extra duty weatherproof while in use” cover consisting of cast aluminum material with padlock hasp, NEMA 3R rated. TayMac MX3200 (duplex vertical), MX3300 (duplex horizontal), MX6200 (quad) or as accepted.
- D. Weatherproof plates for switches shall be single cover, Hubbell HBL7420.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Verify location and mounting height of all receptacles, wall-mounted fixtures, switches, and other equipment before roughing in. Refer to the drawings for pertinent information. Refer questionable cases to the Engineer.

- B. Any receptacle mounted within 6 feet of a sink or basin shall be provided with ground fault protection for personnel.
- C. Any 125 VAC, 15- or 20-amp rated device located in a kitchen shall be provided with ground fault protection for personnel.
- D. Devices shall be mounted parallel and perpendicular to building lines.
- E. For a more attractive installation, all devices at the same location shall be ganged. Separate boxes shall not be acceptable.
- F. Low voltage control wiring routed above ceilings without conduit shall be tied off to lighting fixture support wires. In open ceiling areas supported from appropriate hooks or rings. Excess wire shall be neatly coiled without kinks or sharp bends.

3.02 MOUNTING HEIGHTS

- A. Switches shall be installed at heights matching the architectural elevations. In no case shall switches be mounted higher than 44 inches above finish floor (AFF) to the top of box (or gang outlet ring).
- B. Receptacles shall be installed at heights matching the architectural elevations. In no case shall receptacles be mounted lower than 15 inches to bottom of box (or gang outlet ring) above finish floor (AFF) to the bottom of the lowest plug point or where intended for ADA access, more than 44 inches AFF to the top of box (or gang outlet ring). Receptacles noted at higher mountings shall only be for a specific purpose, not general use.
- C. Groups of switches shown at one location shall be installed under a single plate having the proper number of openings, and appropriate to the location.
- D. Contractor shall review the Engineer's elevations and details to confirm device placement prior to rough-in. Submit questionable mountings to the Engineer for direction.

3.03 WEATHERPROOF DEVICES

- A. Devices shall be positioned according to the cover manufacturer's listing instructions, e.g., horizontal versus vertical mounting.

3.04 WALL BOX DIMMERS

- A. Adjust dimmer faceplate spacing to accommodate full dimmer wattage. Do not remove heat sink fins/rails.

- B. Coordinate dimmer wattage with circuit load to be controlled prior to ordering. Consider fixtures at maximum lamp wattage per NEC 210.21 and 220.14(D).
- C. Install equipment in accordance with manufacturer's recommended application wiring and installation instructions.
- D. Label each dimmer, indicating which load or zone it controls.

3.05 CONTROLLED RECEPTACLES

- A. Where code required, controlled duplex receptacles shall be installed with 50% or 100% automatic occupancy control. Unless specifically indicated on the drawings, all duplex receptacles within each space required to have controlled receptacles shall be the 50% controlled type.
- B. Provide all required components to facilitate the operation of controlled receptacles to "ON" when a space is occupied. This may require occupancy sensor, power pack/relay, a wireless signal pack, and a wireless receiver receptacle for individual or multiple receptacle control if applicable.
- C. Each controlled receptacle shall have the universal receptacle control symbol indicated for 50% or 100% operation as denoted per NEC 406.3(E).

END OF SECTION

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SECTION 26 28 13

OVERCURRENT PROTECTION

PART 1 GENERAL

1.01 SUMMARY

- A. Furnish and install fuses and circuit breakers as specified herein and as indicated on the drawings.
- B. Acceptable fuse manufacturers are Bussmann, Ferraz, and Littelfuse.
- C. Circuit breakers shall be manufactured by the same manufacturer as the equipment within which they are installed.
- D. Submittals: Submit short-circuit interrupting data for all overcurrent devices. Include UL series combination rating data, where applicable, with equipment submittals. Clearly indicate each rating and/or combination being utilized.

PART 2 PRODUCTS

2.01 MATERIALS

- A. General: Provide termination lug quantities to accommodate conductor sizes and quantities shown on the drawings. Increase circuit breaker frame sizes as required.
- B. Fuses:
 - 1. Fuses 601 amperes and larger in switchboards shall be UL Class L, current-limiting, time-delay, 600 volts, with interrupting rating of 200,000 amperes RMS symmetrical (Bussmann KRP-C).
 - 2. Fuses protecting lighting and appliance branch circuit panelboards shall be UL Class RK-1, current-limiting, time-delay, rejection-type, 600 volts or 250 volts, with interrupting rating of 200,000 amperes RMS symmetrical (Bussmann LPS-RK or LPN-RK). Ampere ratings as noted on plans.
 - 3. Fuses protecting motor control centers and transformers shall be UL Class RK-1, current-limiting, time-delay, rejection-type, 600 volts or 250 volts, where interrupting duty is over 200,000 amperes RMS symmetrical (Bussmann LPS-RK or LPN-RK), and UL Class RK-5, time-delay for up to 100,000 amperes RMS symmetrical (Bussmann FRS-R or FRN-R). Ampere ratings as noted on plans.
 - 4. Fuses protecting motor branch circuits shall be UL Class RK-5, time-delay, 600 volts or 250 volts, 200,000 amperes RMS symmetrical interrupting rating, sized at 125% of motor nameplate full load amperes (Bussmann FRS-R or FRN-R).

5. Fuses shall be applied considering upstream devices, in accordance with their UL series combination ratings. All applications of fuses shall be on a single fuse per phase leg basis.
6. Furnish and deliver spare fuses to the Owner as follows:
 - a. Three spares for each type and size, in excess of 60 amperes, used for initial fusing.
 - b. 10% or minimum of three spares for each type and size, up to and including 60 amperes, used for initial fusing.
7. Provide a NEMA 12 spare fuse cabinet with appropriate shelving, and size as required to accommodate spare fuses supplied. Acceptable manufacturers are Hammond, Hoffman, or as accepted. Provide 1-inch by 4-inch laminated, black text on white micarta nameplate with script "SPARE FUSES."

C. Ground Fault Protection:

1. Furnish and install UL listed ground sensor relay system with ground break components for each of the protective devices indicated on the drawings. Each unit shall consist of a coordinated ground sensor with integral test winding, solid-state relay to operate the shunt trip circuit on the circuit protective device, and monitor/test panel. System shall be zero sequence type.
2. Where the overcurrent protection device for which ground fault has been specified includes integral current transformers necessary for phase overcurrent protection, the ground fault functionality may be provided by vector summation of the load current in the phase conductors and neutral conductor(s) ("differential current" or "residual current" method). In such instances, provide a neutral current transformer and associated wiring back to the ground fault relay.
3. The relays shall be of the standard time-delay type and have continuously-adjustable current pickup settings of 100 to 1,200 amperes and continuously adjustable time-delay setting from instantaneous (0.03 second) to 1 second. The monitor panel shall indicate relay operation and provide means for testing the system with or without interruption of service, and must not permit the ground fault system to be inadvertently left in an inactive or OFF state.

PART 3 EXECUTION

3.01 INSTALLATION

A. Fuses:

1. Install fuses in such a manner as to expose manufacturer's label indicating model number and ratings.
2. Legibly write the design fuse type on the inside of the switch cover with an indelible ink marker.

3. Coordinate installation location of the spare fuse cabinet with the Owner, and install prior to Project Closeout.

3.02 OVERCURRENT SIZE VERIFICATION

- A. Confirm maximum overcurrent protective device (MOCP) ratings with mechanical accepted shop drawings for equipment supplied PRIOR TO ORDERING. The Contractor shall adjust the supply circuit breaker and/or fuse ratings to match accepted shop drawing MOCP data per the NEC.
- B. Where equipment includes an adjustable speed drive, upstream overcurrent device and feeder size shall be adjusted to match the rated input current to the accepted drive furnished. In no case shall the overcurrent setting be less than 125% of the nameplate load. Refer to the NEC and Division 23 specifications for requirements. Confirm accepted adjustable speed drives to be supplied PRIOR TO ORDERING related overcurrent device(s) and installing underground conduit.
- C. Prior to project completion, the Contractor shall verify that MOCP ratings match nameplate data for installed equipment. Correct MOCP device sizes as required by the NEC.

END OF SECTION

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SECTION 26 28 16

ENCLOSED SWITCHES & CIRCUIT BREAKERS

PART 1 GENERAL

1.01 SUMMARY

- A. Furnish and install all safety switches and enclosed circuit breakers as shown on the drawings and as required by the NEC.

PART 2 PRODUCTS

2.01 GENERAL

- A. Basis of Design: Drawings are based on Square D. Subject to compliance with requirements, provide the basis of design product or comparable product acceptable to the Engineer by one of the following:
 - 1. Eaton.
 - 2. General Electric.
 - 3. Siemens.
 - 4. Square D.
- B. Switches and circuit breakers shall be mounted in a sheet metal enclosure with externally operable pad-lockable handles. Device mounting shall include an interlocking cover and suitable internal supporting members in the rear of the cabinet. Provide enclosure with an ANSI 61 finish, surface mount, except where shown recessed on the drawings. NEMA 1 for indoor applications, unless noted otherwise. All enclosures outside the building shall have a minimum of NEMA 3R ratings, unless noted otherwise.

2.02 SAFETY SWITCHES

- A. All switches shall be heavy-duty type, externally operated with interlocking cover, quick-make, quick-break, rated 240 volts or 600 volts, as applicable, with the number of poles and ampacity as noted. All switches for motors shall be horsepower rated. All switches outside the building shall have NEMA 3R enclosures. Generally, switches shall be fused, except where noted to be non-fused (NF) on the drawings. Fusible switches shall be capable of accepting Class R rejection fuses, but shall be set up for the fuse class indicated on the drawings.
- B. Disconnect Switches for Fractional Horsepower, 120-Volt, Single-Phase Motors:
 - 1. With Built-In Thermal Overload Protection: Single-pole, manual motor starter with pilot light unless noted otherwise. Starter ampere rating shall match branch circuit breaker.

2. Without Built-In Thermal Overload Protection: Single-pole, manual motor starter with thermal overload protection and pilot light, unless noted otherwise. Starter ampere rating shall match branch circuit breaker. Overload elements shall be sized per motor manufacturer's recommendations and NEC Article 430.32. Maximum ambient temperatures shall be considered when sizing overload elements.
- C. Disconnect switches for fractional horsepower motors larger than 1/2 horsepower, for integral horsepower motors, and for equipment of similar capacity shall be provided per this section.
- D. Disconnect switches for small 120-volt equipment 12 amps or less, shall be specification grade, single-pole, 15-amp toggle switch with pilot light.
- E. Where a local disconnect switch for an item of equipment is remotely located on the load side of a variable frequency drive (VFD), provide the disconnect switch with a factory-installed electrical interlock kit. The interlock kit contact shall be wired into the VFD shutdown control to prevent damage to the VFD in the event of operation of the switch while equipment is under load. The interlock kit shall be field adjusted to insure the interlock contact operates before switch blades open.

2.03 ENCLOSED CIRCUIT BREAKERS

- A. Provisions of Specification Section 26 28 13, Overcurrent Protection, shall apply.
- B. Circuit Breakers: Circuit breakers shall be molded-case, trip-free, quick-make, quick-break, thermal-magnetic type, with handles clearly indicating rating and position – ON, OFF, or TRIPPED. Where series combinations are noted to be applied on the plans, UL series combination ratings shall be maintained with upstream overcurrent device(s).

PART 3 EXECUTION

3.01 EQUIPMENT SIZE VERIFICATION

- A. Confirm disconnect ratings with mechanical shop drawings for equipment supplied PRIOR TO ORDERING. The Contractor shall adjust minimum sizes provided based on nameplate data per NEC 430 and 440.

3.02 INSTALLATION

- A. Install switches at locations indicated on the drawings, using approved fastening methods, and maintaining proper working clearances working clearances per NEC 110.26 and mounting parameters per NEC 404.

- B. Where it is not possible to install switches on a wall, structure, or item of equipment, provide rigid, freestanding supports of galvanized angle or channel. Supports shall be primed and painted.
- C. Circuit Breakers: Set adjustable circuit breakers per the engineered coordination settings. Reference Specification Section 26 05 00, General Provisions.
- D. Ground Fault Protection: Set trip unit per the engineered coordination settings. Reference Specification Section 26 05 00, General Provisions.

3.03 OVERCURRENT SIZE VERIFICATION

- A. Confirm maximum overcurrent protective device (MOCP) ratings with accepted mechanical shop drawings for equipment supplied PRIOR TO ORDERING. The Contractor shall adjust the supply circuit breaker and/or fuse ratings to match accepted shop drawing MOCP data per NEC 430, 440, and 695.
- B. Where equipment includes an adjustable speed drive, upstream overcurrent device and feeder size shall be adjusted to match the rated input current to the accepted drive furnished. In no case shall the overcurrent setting be less than 125% of the nameplate load. Refer to the NEC and Division 23 specifications for requirements. Confirm accepted adjustable speed drives to be supplied PRIOR TO ORDERING related overcurrent device(s) and installing underground conduit.
- C. Prior to project completion, the Contractor shall verify that MOCP ratings match nameplate data for installed equipment. Correct MOCP device sizes as required by NEC 430, 440, and 695.

END OF SECTION

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SECTION 26 51 00

INTERIOR LIGHTING FIXTURES & LAMPS

PART 1 GENERAL

1.01 SUMMARY

- A. Furnish and install all interior lighting fixtures with lamp assemblies as specified and as shown on the drawings. Lighting fixtures shall be complete, including canopies, hangers, reflectors, diffusers, drivers, etc.

1.02 ACTION SUBMITTALS

- A. Provide a product-specific submittal for each lighting fixture type. Catalog cut sheets illustrating conformance with specifications will be acceptable for standard units. Drawings shall indicate materials, assembly, finish, and dimensions.
- B. Photometric data shall be furnished for all lighting fixtures listed on the Lighting Fixture Schedule, and shall include the following:
 - 1. Light engine output assembly type used in photometric tests.
 - 2. Fixture candela curve with perpendicular and parallel sections.
- C. LED (light-emitting diode) light engine and driver data matrix shall include the following:
 - 1. LED light engine assembly type, wattage, dimensions, light engine color temperature in Kelvin, and Color Rendition Index for each type of lighting fixture.
 - 2. Driver type, quantity per lighting fixture, wattage/ampereage, voltage, switching criteria, and dimensions for each type of lighting fixture. Clearly indicate driver power factor, load (ma), and compliance to the specifications.

1.03 WARRANTY

- A. LED lamps and drivers shall have a 24-month warranty. Lamps and drivers that fail during the initial 24-month warranty period will be replaced and installed at no cost to the Owner. Lamp failure is defined to be failure of more than 10% of the LEDs within the fixture for a specific distribution (up, down, etc.).

PART 2 PRODUCTS

2.01 GENERAL

- A. All catalog numbers are given for manufacturer's identification and do not relieve the Contractor from responsibility of full conformance to all applicable written description requirements governing material and fabrication, either in the general or specific sections. Where conflicts occur, the most expensive option shall be enforced. Where catalog numbers are indicated as modified, no modification will be required if the standard unit fully conforms to descriptive requirements in the specifications and matches the specified installation requirements.
- B. All lighting fixtures of the same type shall be of one manufacturer and of identical finish and appearance.
- C. All lighting fixtures and component parts shall bear the UL label.
- D. All lamp assemblies installed within the same lighting fixture type shall be of the same manufacturer.
- E. All drivers installed within the same lighting fixture type shall be of the same manufacturer.
- F. Where intrusion protection (IP) ratings are specified, provide documentation indicating compliance.
- G. Clearly indicate any deviations to dimensions of specified lighting fixture.

2.02 CONSTRUCTION

- A. All steel parts shall be phosphate treated in multi-stage power spray system for corrosion resistance and paint adhesion. Standard final finish shall be electrostatically applied, baked white enamel of not less than 87% reflectance on reflecting surfaces. Refer to the Lighting Fixture Schedule and/or the drawings for other finish types.
- B. Each recessed/flush-mounted lighting fixture shall have a continuous light-seal gasket seated in such a manner as to prevent any light leakage through any portion or around any edge of the trim frame.
- C. Lenses/diffusers shall be framed in a hinged continuous assembly. Lens/diffuser frame latches shall be loaded or cam operated. Where noted on the drawings, provide tamper-resistant latches.
- D. All lighting fixture sockets shall be securely fastened to the lighting fixture body to prevent movement during relamping.

- E. For recessed lighting fixtures, provide a through-wiring junction box set to the side, where it shall be accessible when the lighting fixture reflector assembly is removed from the lighting fixture housing. Connect the box to the lighting fixture housing with flexible conduit. Clearly indicate when a lighting fixture requires above-soffit/ceiling access.
- F. All recessed lighting fixtures shall be provided with frames appropriate for the type of soffit/ceiling involved. No lighting fixtures shall be submitted for review or ordered until the soffit/ceiling construction and mounting method have been verified by the Contractor.
- G. The finish of all lighting fixtures is subject to final approval by the Engineer. Furnish paint chips to the Engineer for selection for all non-standard finishes. Color selection shall be reviewed by the Engineer prior to the review of submittals by the Engineer.
- H. All electrical requirements for lighting fixtures shall be verified with the drawings, catalog number, and Lighting Fixture Schedule prior to ordering.
- I. The Contractor shall provide dimming and switching as indicated on the plans. The driver quantities shall be determined by the required switching criteria.
- J. Fixture manufacturer will test and ensure compatibility of the system components including, but not limited to, light source (engine), luminaire, driver power supply, and control interface with added components as needed for a complete and functioning system.

2.03 DRIVERS

- A. LED drivers shall be high power factor electronic type. An audible noise rating of Class A shall be maintained. Driver and lamp combination shall match for optimum operational efficiency. Provide reverse polarity protection, open circuit protection requiring no minimum load. Provide 80% minimum efficiency. Manufactured by Advance, CREE, Osram Sylvania, Philips, or as accepted.
- B. Provide LED Dimming: Provide system capable of full range continuous dimming, 0- to 10-volt control.
- C. Drivers shall be CBM certified, bear the UL label, and have a sound rating of "A."
- D. Driver shall be modular in design, readily available as a replacement component, designed to be removable and replaceable from within a fixture. Driver shall not be integral to the light engine circuit board.

- E. Lighting fixtures located within low temperature, damp, and wet environments shall have drivers designed for proper operation.
- F. The Contractor shall be responsible for the replacement of drivers due to excessive noise or failure within the project warranty period.

2.04 LENSES/DIFFUSERS/LOUVERS/REFLECTORS

- A. Lenses/diffusers shall be furnished as indicated on the drawings.
- B. Lenses/diffusers shall be 100% virgin acrylic with a minimum thickness of 1/8 inch (0.125 inch), Pattern A19, unless noted otherwise on the drawings.
- C. No lens/diffuser shall be manufactured with polystyrene, copolymer (mixture of polystyrene and acrylic), or reclaimed or recycled acrylic plastic.
- D. All parabolic louvers and open reflectors shall be shipped with a protective plastic covering or coating. The protective covering shall not be removed until all construction is complete and final lighting fixture assembly is complete. The Contractor shall be responsible for cleaning all louver assemblies; in particular, removing all smudges, fingerprints, dust particles, etc.
- E. All reflector or louver striations deemed unacceptable by the Engineer shall be replaced prior to project closeout.
- F. Align lenses/diffusers/louvers/reflectors for all lighting fixtures in a like manner, unless noted otherwise.
- G. Clean luminaire reflector systems, lenses, and enclosures after all construction dust has been removed from the area.

2.05 SUPPORT

- A. Surface- or pendant-mounted lighting fixtures shall be supported as follows:
 - 1. From the outlet box by means of a metal strap, where its weight is less than 5 pounds.
 - 2. From its outlet box by means of a hickey or other threaded connection, where its weight is from 5 to 50 pounds.
- B. Lighting fixtures shall be supported independently of the ceiling system or additional ceiling suspension must be added to support the weight of the lighting fixtures. It is the responsibility of the Electrical Contractor to coordinate all support requirements with the ceiling system installer. Recessed lighting fixtures supported from ceiling grid tee systems shall be furnished with hold-down clips in conformance with NEC 410.36.

- C. Furnish and install supplementary blocking and support as required to support lighting fixtures from structural members. This blocking may include multiple members and shall be coordinated with the Structural Engineer prior to rough-in.
- D. Suspended lighting fixtures shall be stem mounted and shall be free to swing 20 degrees in any direction. Ceiling swivels shall be of the ball-aligner type.
- E. Chain suspension may be used only where specifically permitted on the drawings. Chain shall be heavy-duty, nickel- or cadmium-plated, suitable for weight of specific lighting fixture. Lighting fixtures installed in rows, continuous or spaced apart, shall be attached to a unistrut-type backbone. This backbone shall align all lighting fixtures true, straight, and level. Where chain suspension is not allowed, provide 1/4-inch-diameter, all-thread nickel- or cadmium-plated rod.
- F. All supports, where not concealed, shall be painted. Coordinate paint requirements with the Engineer.

2.06 LAMPS

- A. LED Light Engines:
 - 1. LED light engines shall provide illumination with CRI greater than 80.
 - 2. LED light engines shall comply with ANSI chromaticity standard for classifications of color temperature. Reference Luminaire Schedule for specified LED lamp color and color temperature. LED light engines shall be UL or ETL listed and labeled.
 - 3. LED light engines shall be luminaire tested per IESNA LM-79 and LM-80 requirements.
 - a. Lamp Life for White LEDs: 100,000+ hours with lamp failure occurring when LED produces 70% of initial rated lumens.
 - b. Lamp Life for Color LEDs: 50,000+ hours with lamp failure occurring when LED produces 50% of initial rated lumens.
 - 4. LED Light Source Manufacturers: CREE, GE Lighting, Nichia, Osram Sylvania, Philips, or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Fixtures installed in rows shall be aligned. For square trims, the flat sides shall be aligned to other fixtures in the row; or where individually mounted, aligned with the surrounding walls.
- B. Pendant fixtures shall be installed level, unless otherwise noted. Pendant fixtures occurring in rows shall be vertically and horizontally aligned.

- C. Protective films or covers shall be provided for each fixture to prevent dust and debris contamination of the fixture interior. These covers shall remain in place until substantial completion.
- D. Cleaning of reflectors shall be performed as recommended by the manufacturer. At minimum, protective gloves shall be worn to prevent body oils from contacting the reflector.

3.02 LIGHTING FIXTURE OPERATION

- A. Test for proper operation of all lighting fixtures, including control requirements for each. This may include line-voltage or low-voltage switching and/or dimming requirements.

END OF SECTION

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